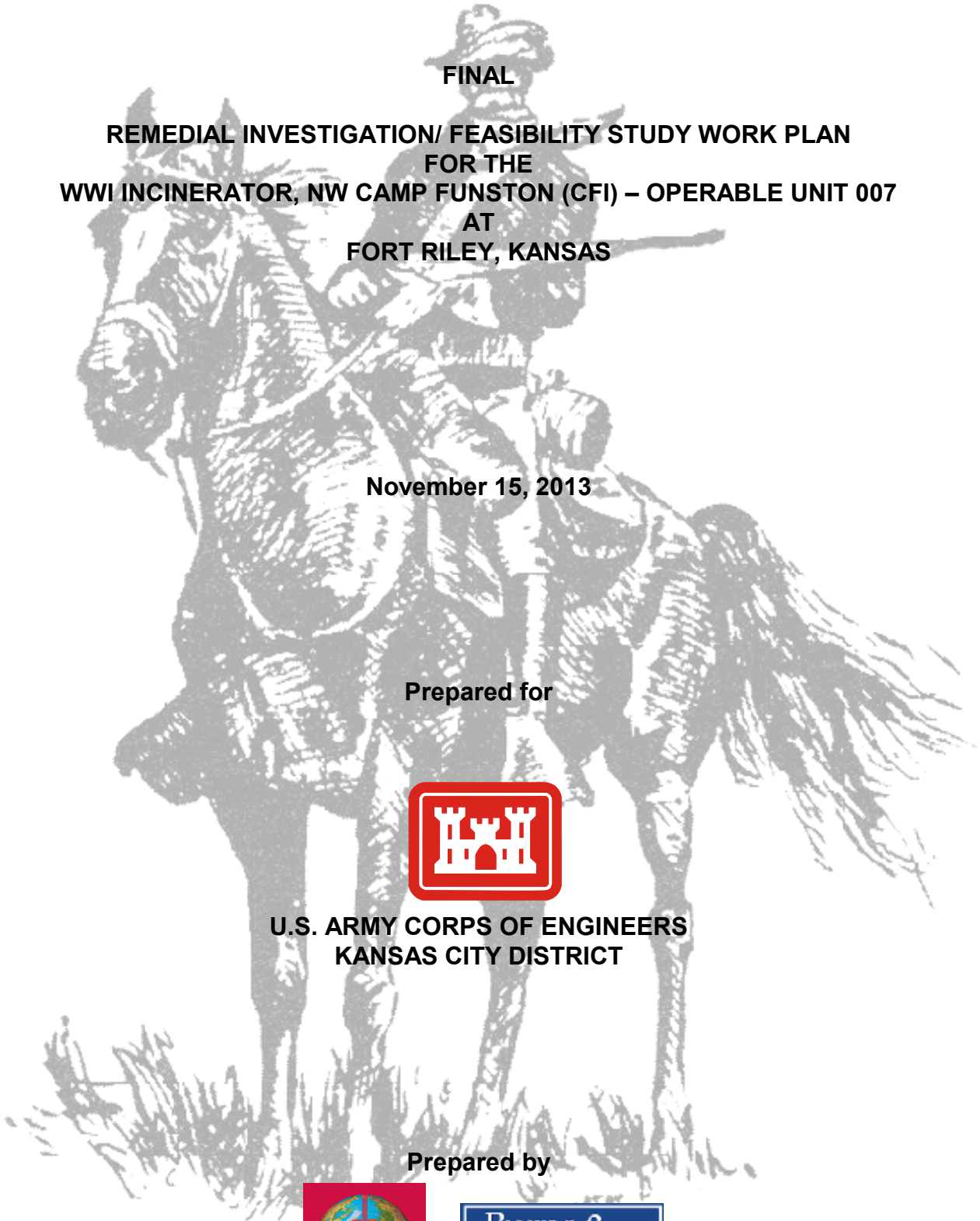

FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN FOR THE WWI INCINERATOR, NW CAMP FUNSTON (CFI) – OPERABLE UNIT 007 AT FORT RILEY, KANSAS

November 15, 2013

Prepared for

U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Prepared by

Contract Number: W912DQ-08-D-0017
Project Number: 63525

Final Remedial Investigation/ Feasibility Study Work Plan for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at, Fort Riley, Kansas

11/15/2013

Prepared for

U.S. Army Corps
of Engineers
Kansas City District

Prepared by

Burns & McDonnell
SINCE 1898

Contract Number:
W912DQ-08-D-0017
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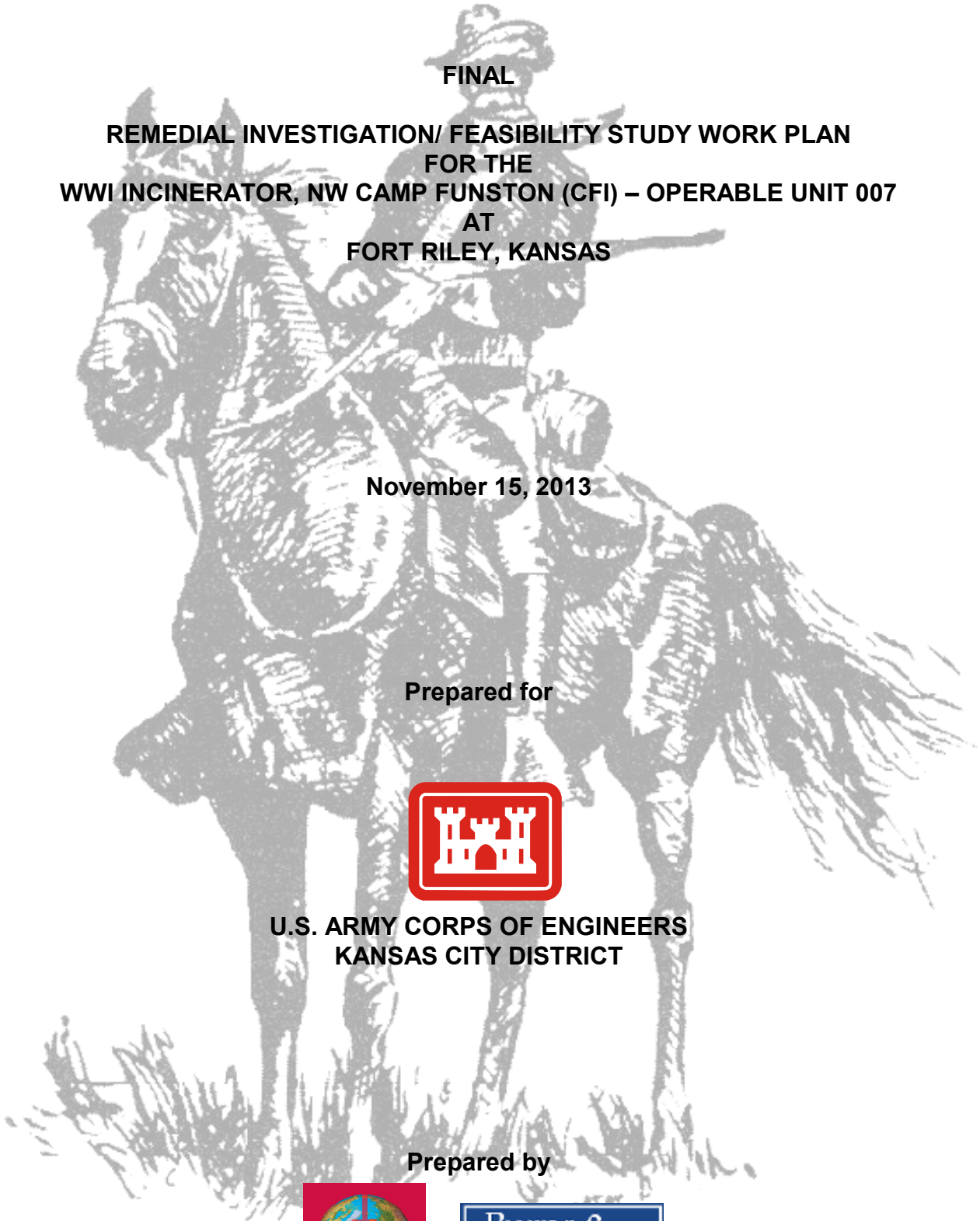

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D	Site-Specific Sampling and Analysis Plan (including Site-Specific UFP-Quality Assurance Project Plan)

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
Arrowhead	Arrowhead Contracting, Inc.
Basic Documents	Basic Documents for Environmental Investigations at Fort Riley, Kansas
BER	Bureau of Environmental Remediation
bgs	below ground surface
BLRA	Baseline Risk Assessment
BMcD	Burns & McDonnell Engineering Company, Inc.
BRL	Brooks Rand Labs, LLC.
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CAA	Clean Air Act
CENWK	Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFI	WWI Incinerator, NW Camp Funston
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COC	Chain of Custody
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
CTI	CTI & Associates
CWA	Clean Water Act
DA	United States Department of the Army
DRO	Diesel Range Organics
DO	Dissolved Oxygen
DoD	Department of Defense
DQCR	Daily Quality Control Report
DQI	Data Quality Indicator
DQO	Data Quality Objective
ECC	Environmental Chemical Corporation
ELAP	Environmental Laboratory Accreditation Program
EPS	Environmental Priority Services, Inc.
ºF	degrees Fahrenheit
Fort Riley	Fort Riley Military Reservation
FS	Feasibility Study
FSM	Field Site Manager
ft	feet
gpd	gallons per day
gpm	gallons per minute
GRA	General Response Action
Greenfield	Greenfield Contractors, Inc.

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GRO	Gasoline Range Organics
H_a	Alternative Hypothesis
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
H_o	Null Hypothesis
IDW	Investigative-Derived Waste
in/yr	inches per year
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IW-APP/SSHP	*Installation-Wide Accident Prevention Plan and Site Safety and Health Plan, for Environmental Investigations at Fort Riley, Kansas*
IW-IDW	*Installation-Wide Investigative-Derived Waste Management Plan for Environmental Investigations at Fort Riley, Kansas*
J flag	estimated result
K.A.R.	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment
K.S.A.	Kansas Statute Annotated
KWPC	Kansas Water Pollution Control
LBG	The Louis Berger Group, Inc.
LOAEL	Lowest Observable Adverse Effects Level
MAAF	Marshall Army Airfield
MCL	Maximum Contaminant Level
MeHg	Methyl Mercury
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
MDL	Method Detection Limit
mph	miles per hour
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observable Adverse Effects Level
NRCS	National Resources Conservation Service
NW	Northwest
NWI	National Wetland Inventory
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
OU 007	Operable Unit 007
PAH	Polycyclic Aromatic Hydrocarbon
PAR	Pathways Analysis Report
PG	Professional Geologist

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PGM	Program Manager
PID	Photoionization Detector
PM	Project Manager
POC	Point of Contact
POL	Petroleum, Oil, and Lubricant
PP	Proposed Plan
PRG	Preliminary Remediation Goal
PPRTV	Provisional Peer Reviewed Toxicity Values
PWE	Fort Riley Directorate of Public Works – Environmental Division
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	*Quality Control Plan, for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*
QCSR	Quality Control Summary Report
RAA	Remedial Action Alternative
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
Razek	Razek Environmental, LLC
RCRA	Resource Conservation and Recovery Act
RIP	Remedy in Place
RL	Reporting Limit
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPMP	Real Property Master Plan
RI	Remedial Investigation
RSK	Risk-Based Standards for Kansas
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SAP-IW	*Sampling and Analysis Plan, Installation-Wide, for Fort Riley CERCLA Process Support for Environmental Investigations at Fort Riley, Kansas*
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHM	Project Safety and Health Manager
SOP	Standard Operating Procedure
SOW	Scope of Work
SQuiRTs	Screening Quick Reference Tables
SS-SAP	*Site-Specific Sampling and Analysis Plan (including Site-Specific UFP – Quality Assurance Project Plan), for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*
SS-IDW	*Site-Specific Investigative-Derived Waste Management Plan, for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*
SSHO	Site Safety and Health Officer
STSC	Superfund Health Risk Technical Support Center
SVOC	Semi-Volatile Organic Compound

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TEC	Threshold Effect Concentration
TestAmerica	Test America, Inc. – West Sacramento
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSWP	Treatability Study Work Plan
UCL	Upper Confidence Limit
UFP	Uniform Federal Policy
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USDA	United Stated Department of Agriculture
USDoC	United States Department of Commerce
USC	United States Code
USEPA	United States Environmental Protection Agency
WP	Work Plan
WWI	World War I
XRF	X-Ray Fluorescence

* * * * *

1.0 INTRODUCTION

The Fort Riley Directorate of Public Works – Environmental Division (PWE) is performing the Installation Restoration Program (IRP) for the Fort Riley Military Reservation (Fort Riley) at Fort Riley, Kansas. This program, designed to identify and address potential threats to human health and the environment, has been underway for several years at Fort Riley. Numerous investigations, pilot studies, and environmental sampling events have been conducted by the United States Army Corps of Engineers (USACE) – Kansas City District (CENWK) at several sites at Fort Riley to support the IRP effort.

Based upon the results of previous investigations, Fort Riley will conduct a Remedial Investigation (RI)/Feasibility Study (FS) at the World War I (WWI) Incinerator, Northwest (NW) Camp Funston (CFI) – Operable Unit 007 (OU 007). This RI/FS Work Plan (WP) has been prepared for the Fort Riley PWE and USACE-CENWK for the work to be conducted at the CFI Site. This RI/FS WP was written to satisfy the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The work will be conducted under Contract Number W912DQ-08-D-0017 by The Louis Berger Group, Inc. (LBG) and Burns & McDonnell Engineering Company, Inc. (BMcD).

1.1 OBJECTIVES

This RI is being conducted to further investigate the CFI Site, which was not been fully defined in previous environmental investigations.

The objectives of the CFI Site RI are:

- Determine the nature and extent of contamination at the CFI Site in media such as surface soil, subsurface soil, stream sediment, surface water, and groundwater;
- Quantify the nature and extent of the CFI ash at the CFI Site;
- Characterize the physical and chemical nature of contamination at the CFI Site, including fate and transport mechanisms;
- Refine the conceptual site model (CSM);
- Obtain information necessary to evaluate risk, as needed, in the Baseline Risk Assessment (BLRA); and

- Obtain information necessary to evaluate remedial alternatives, as needed, in the FS.

The objective of the CFI Site BLRA is:

- Determine potential ecological and human health risk posed by contamination at the CFI Site.

The objective of the CFI Site FS is:

- Develop and evaluate remediation alternatives, as appropriate.

The RI/FS at the CFI Site will be performed in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations, and will follow the United States Environmental Protection Agency (USEPA) and Kansas Department of Health and Environment (KDHE) methodologies such as the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988), the *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Parts A,B,E, and F)* (USEPA, 1989, 1991, 2004, and 2009a); other USEPA supplemental guidance; and the KDHE *Risk-Based Standards for Kansas (RSK) Manual – 5th Version* (KDHE, 2010).

1.2 ORGANIZATION OF THE RI/FS WP

The RI/FS WP presents the technical approach, rationale, and investigative methods that will be used to achieve the RI, BLRA, and FS objectives. The sections of the RI/FS WP are as follows:

- Section 2.0 – Background and Physical Setting
  This section of the RI/FS WP summarizes the current knowledge of the CFI Site physical characteristics, including location, general description, surface features, climatology, surface water hydrology, hydrogeology, geology and soils, demography, and ecology. A site history and a summary of previous investigations are also included in this section.

- Section 3.0 – Initial Evaluation
  This section of the RI/FS WP presents an initial evaluation of the CFI Site. Possible chemicals of potential concern (COPCs), the current conceptual model for the CFI Site, and potentially applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) information are presented. Preliminary remedial action objectives (RAOs), potential remedial action alternatives (RAAs), and general response actions (GRAs) are also identified in this section.

- Section 4.0 – WP Rationale

  This section of the RI/FS WP provides a bridge from the initial evaluation to the detailed scope of work (SOW) by presenting the approach to be used to determine and fill data needs at the CFI Site. This includes a statement of specific project objectives, tabulation of data needs, and development of the WP approach.

- Section 5.0 – RI/FS SOW

  This section of the RI/FS WP presents the overall SOW for the CFI Site. Descriptions are provided for all RI/FS standard tasks including project plan preparation, field investigation activities, sample analysis/validation, data evaluation, risk assessment, RI Report preparation, remedial alternatives development/screening, detailed analysis of alternatives, and FS report preparation.

- Section 6.0 – Data Evaluation and Sample Rationale

  This section of the RI/FS WP details the area to be investigated at the CFI Site. Sampling results from the previous environmental investigations are presented. Additionally, the rationale and approach for sampling at the CFI Site is detailed including sample locations, types and analytes.

- Section 7.0 – Project Schedule

  This section of the RI/FS WP provides a detailed project schedule of the activities to be performed.

- Section 8.0 – Project Management

  This section of the RI/FS WP details the approach to organizing and managing the RI/FS. The responsibilities of key project personnel are also described.

- Section 9.0 – References

  The references used to prepare this RI/FS WP are provided in this section.

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2.0 BACKGROUND AND PHYSICAL SETTING

2.1 INTRODUCTION

This section of the RI/FS WP describes the CFI Site location, discusses the physical settings, and reviews the history and the previous environmental investigations. Current information about the CFI Site including topography, climatology, hydrogeology, and geology are discussed. These topics are helpful for the following reasons. Topography affects surface flow, surface water, and sediment. Climatology provides general weather conditions such as prevailing wind transport conditions and precipitation amounts. Hydrology and hydrogeology focuses on the overland flow of surface water and groundwater flow within the subsurface at the CFI Site. Geology provides information on chemical and physical characteristics of subsurface materials. This section also describes past and current land use and an overview of previous sampling activities and results.

2.2 LOCATION AND DESCRIPTION

Fort Riley is located in north-central Kansas (see Figure 2-1). The Post was established in 1853 and has been owned and operated by the United States Department of the Army (DA) since that time. The Reservation is over 100,000 acres in size and includes portions of Riley, Clay, and Geary Counties. The developed areas of Fort Riley are divided into six cantonment areas (see Figure 2-1): Historic Main Post, Camp Forsyth, Camp Funston, Camp Whitside, Marshall Army Airfield (MAAF), and Custer Hill.

The CFI Site is located in the western portion of the Camp Funston cantonment area within Riley County and occupies approximately two acres. The CFI Site sits approximately 300 feet (ft) southeast of the Huebner Road/Williston Point Road roundabout, directly southeast of the Union Pacific Railroad (UPRR) grade, and directly southwest of Threemile Creek (see Figure 2-2). The investigation area is shown on Figure 2-3.

2.3 PHYSICAL SETTING

2.3.1 Surface Features

2.3.1.1 Regional Surface Features

The topography of Fort Riley and the surrounding area consists of a low plain that has been eroded by streams and rivers. The area is designated as the Osage Plains section of the Central Lowlands physiographic province (Schoewe, 1949). Sedimentary bedrock strata dip gently to the west-northwest. East-facing escarpments of more resistant rock units are separated by gentle, westward sloping plains. The resulting topography can be divided into upland areas with bluffs along alluvial valleys, and lowland areas which consist of alluvial plains and associated terraces. The upland areas are dissected by

numerous intermittent and perennial streams. The lowlands areas occur along the banks of the major rivers in the area including; the Republican, Smoky Hill, and Kansas Rivers (Jewett, 1941).

2.3.1.2 Site-Specific Surface Features

The CFI Site is located at the transition of the terrace into the Kansas River alluvial valley and includes three distinct areas; the upland terrace area, the floodplain slope, and the Kansas River floodplain. The upland terrace area is relatively flat and drains southeast toward Threemile Creek. The floodplain slope is relatively steep with an approximate 3 to 1 slope. The floodplain slope is approximately 16 ft high and extends approximately 50 ft laterally between the upland terrace area and the Kansas River floodplain (CTI & Associates [CTI], 2010). The floodplain slope also drains southeast toward Threemile Creek. The Kansas River floodplain is relatively flat and drains southeast toward Threemile Creek.

2.3.2 Climatology

The average temperature for the area (measured at Station 144972, located in Manhattan, Kansas, approximately 10 miles east-northeast of the CFI Site) is 55 degrees Fahrenheit (ºF). Temperature extremes range from a record low of -31 ºF (January 1947) to a record high of 116 ºF (August 1936). Annual precipitation from 1900 through 2010 ranged from a minimum of 15.42 inches to a maximum of 60.38 inches, with an average of approximately 33 inches per year (in/yr). The maximum 24-hour rain event during the same period was reported at 6.28 inches. Average annual snowfall is approximately 18 inches with a maximum annual snowfall during the reporting period of 49.5 inches in 1960. The maximum 24-hour snowfall event during this same time period was reported as 18 inches (High Plains Regional Climate Center, 2011). Pan evaporation, measured by the USACE at Tuttle Creek Lake north of Manhattan, averaged 47.13 in/yr between 1980 and 1997, with extremes of 37.39 in/yr and 58.66 in/yr.

Prevailing wind directions are variable. Winds are predominantly from the south and southwest during March through December, and winds are predominately from the north during the months of January and February. Wind speeds generally range from seven to ten miles per hour. Wind speeds of up to 110 miles per hour (mph) have been recorded at MAAF (personal communication, First Weather Group, Detachment 8, Fort Riley MAAF, 1998).

2.3.3 Geology and Soils

2.3.3.1 Regional Geology and Soils

The geology of Fort Riley and the surrounding area consists of Pennsylvanian and Permian Age sedimentary rock overlain by eolian and fluvial deposits of Pleistocene and Recent Age (Jewett, 1941). The Nemaha Anticline is the prominent structural feature in the area, and Fort Riley is situated on the

western limb of this fold within the Salina Basin (Merriam, 1963). Bedrock dips gently (approximately 30 ft per mile) to the west-northwest and consists of alternating beds of limestone and shale of the Permian Chase and Council Grove Groups. The Barnestone Formation of the Chase Group (composed of the Fort Riley Limestone, Oketo Shale, and Florence Limestone Members) is the uppermost bedrock in the upland areas. This sequence of interbedded limestones and shales continues to depths of several hundred ft. The bedrock surface has been eroded by the major rivers and streams. The major streams tend to flow to the east and south. The rivers are broad, shallow, and slow-moving.

In the major river valleys, alluvial sand, silt, and gravel deposits reach a thickness of approximately 100 ft near the rivers and decrease in thickness toward the margins of the floodplain. Alluvium and loess cover portions of the upland areas, including terraces underlain by Buck Creek terrace deposits (Fader, 1974). These terrace deposits include both alluvium and loess. Eudora and Kenesaw soils are developed throughout Fort Riley (Jantz et al., 1975). Eudora silt loams are well drained, have moderate permeability, and normally form in coarse, silty alluvium on high flood plains or low terraces. Kenesaw silt loams are well drained, have moderate permeability, and form in loess on deep gently sloping and sloping soils on uplands (United States Department of Agriculture - Natural Resources Conservation Service [USDA-NRCS], in cooperation with the Kansas Agriculture Experiment Station, 2005).

2.3.3.2 Site-Specific Geology and Soils

The geology of the CFI Site consists of alluvial sediments overlying Permian age sedimentary rock composed of alternating sequences of shale and limestone. Soil borings from two, nearby, environmental sites (Petroleum, Oil, and Lubricant [POL] Site 1044 and Building 1460), located in the northwestern most part of Camp Funston along the Kansas River floodplain, indicate fine to coarse sand at depth grading to a silty clay near the surface (Environmental Chemical Corporation [ECC]-BMcD, 2005 and LBG-BMcD, 2010). Eudora soils are present in the alluvial valley to the south and east of the UPRR grade. Kenesaw soils are present on the Buck Creek terrace deposits north of the UPRR grade. These soils are also well drained and moderately permeable. Kenesaw soils, which are well drained and moderately permeable, are the predominant soil type present at the CFI Site (USDA-NRCS, in cooperation with the Kansas Agriculture Experiment Station, 2005).

2.3.4 Surface Water Hydrology

2.3.4.1 Regional Surface Water Drainage

Fort Riley is located along the Kansas River, and is surrounded by other large bodies of water associated with the Kansas River system. The river system in the area includes Milford Lake (a reservoir on the Republican River) to the west, the Republican River (downstream of Milford Lake to the southwest), and

the Smoky Hill River to the south. The Republican and Smoky Hill Rivers merge to form the Kansas River approximately six miles west of the CFI Site. There are numerous other intermittent and perennial creeks/streams that dissect Fort Riley, eventually feeding into the large rivers identified above (Jewett, 1941).

2.3.4.2 Site-Specific Surface Water Drainage

Threemile Creek is located immediately northeast of the CFI Site. Stormwater runoff drains from the upland portions of the CFI Site into Threemile Creek. Threemile Creek flows to the east/southeast and drains into the Kansas River (see Figures 2-1 and 2-2).

2.3.5 Hydrogeology

2.3.5.1 Regional Hydrogeology

Fort Riley lies within the Nonglaciated Central Region Groundwater Province (Heath, 1984). This region is hydrogeologically complex and is generally characterized by both consolidated rock aquifers having low yields and alluvial aquifers having moderate to high yields along the major rivers. In Geary and Riley Counties, both types of aquifers are present. Consolidated Permian limestone and shale aquifers produce small quantities of groundwater in the uplands areas. These aquifers are developed within fractures and cavities in the Permian Chase and Council Grove Groups (Buchanan and Buddemeier, 1993). In the river valleys, aquifers are developed within the unconsolidated alluvial sediments deposited by the rivers and major streams. These alluvial aquifers are unconfined and water wells completed within the floodplain deposits can have high yields in the hundreds of gallons per minute (gpm). Elevated alluvial terrace deposits, which are located along the margins and above the modern floodplain, also act as low-yield aquifers. These deposits usually have lower transmissivities than the deposits of the modern alluvial floodplain because the saturated thickness of sediments is much less, and consequently, not a reliable supply of water. However, the terrace aquifers do provide recharge to the Kansas River alluvial aquifer and can act as conduits for contaminants. Alluvial, terrace, and bedrock aquifers are present at Fort Riley.

Three hydrogeologic environments are present at Fort Riley: the river valley consisting of alluvial sediments including clay, silt, and sand, and gravel; the upland terrace areas consisting of a thin, unconsolidated sedimentary regolith over bedrock; and the transition zones along the river valley margins where colluvial deposits from the upland terraces overlie and intermingle with alluvial river deposits. The unconsolidated materials are underlain by bedrock, which, consists of alternating beds of limestone and shale (Jewett, 1941 and Fader, 1974).

The regional groundwater flow within the alluvium generally flows in the down gradient direction of the Kansas River. In the area of Fort Riley, the Kansas River, as shown by comparison of river stage to groundwater levels in the aquifer, can act as either a gaining or a losing stream dependent upon season, precipitation, and water release from Milford Lake. When behaving as a gaining stream, the water level in the river is lower than the water level in the aquifer, and groundwater flow provides recharge to the river. As a losing stream, the water level is higher in the river than the surrounding alluvial aquifer, and flow from the river provides recharge to the aquifer.

2.3.5.2 Site-Specific Hydrogeology

The CFI Site is located at the transition zone between the alluvial aquifer of the Kansas River valley and the upland terrace area. The alluvial aquifer of the Kansas River underlies the CFI Site. Based upon previous environmental investigations at POL sites, POL Site 1044 and Building 1460 (ECC-BMcD, 2005 and LBG-BMcD, 2010), the depth to groundwater is estimated to be 18 ft to 25 ft below ground surface (bgs) on the Kansas River floodplain and 34 ft to 42 ft bgs on the upland terrace area. POL Site 1044 and Building 1460 are located approximately one-half mile east of the CFI Site on the western edge of the active Camp Funston Boundary. The groundwater flow direction at the CFI Site is anticipated to be east/southeast toward the Kansas River.

2.3.6 Demography

According to the Fort Riley 1st Infantry Division webpage, the current assigned-served manpower/population is approximately 32,000 people. This population is broken down to approximately 1,100 active duty officers, 9,200 active duty enlisted, 12,400 family members, 5,962 retirees, and 3,300 civilian work force (1st Infantry Division, 2013).

There is currently no one who lives or works at the CFI Site. The lands surrounding the CFI Site consist of undeveloped lands and the UPRR. In addition to the other cantonment areas of Fort Riley (all of which are within six miles of the CFI Site), the following towns are within ten miles of the CFI Site: Junction City and Grandview Plaza (adjacent to the south) and Ogden (approximately six miles to the northeast). The approximate populations of the surrounding major towns are: Junction City (23,353), Grandview Plaza (1,560), and Ogden (2,087) (United States Department of Commerce [USDoC], 2010).

2.3.7 Land Use

Land use at Camp Funston at Fort Riley is related to the operations of an active Army installation. Camp Funston is used to support active military training, housing, and military operations which are expected to continue into the next century. According to the Fort Riley Real Property Master Plan (RPMP) the land

use for the area where the CFI Site located is currently classified as open space (Black & Veatch, 2007). Future land use at the CFI Site is likely to remain the same; however, during the BLRA, all land use scenarios will be considered based upon land use near the CFI Site as discussed below.

The area in the immediate vicinity of the CFI Site is currently unused wood/brush-covered land. Building 1460 located approximately a half mile east of the CFI Site is used for the repair, maintenance, and storage of vehicles and heavy equipment. There is an active fire station approximately a half mile northeast of the CFI Site on Huebner Road. There is active military housing (barracks) northwest of the CFI Site on Huebner Road. The Camp Funston Wastewater Treatment Plant is located approximately a quarter mile south of the CFI Site. The former Southwest Funston Landfill lies approximately a half mile south of the CFI Site. The UPRR tracks, which run immediately northwest of the CFI Site, support moderately heavy rail traffic, with several freight trains both east and westbound each day.

2.3.8 Groundwater Use

Fort Riley and the communities of Junction City and Ogden rely on groundwater drawn from alluvial sediments for municipal drinking water supplies. The Fort Riley water supply wells are in the alluvial valley, approximately eight miles up-gradient of the CFI Site near Camp Forsyth. The nearest water supply wells are approximately three miles east of the CFI Site, on the southern portion of the Kansas River floodplain. There are no water supply wells located on the floodplain between the CFI Site and the Kansas River.

2.3.9 Ecology

Fort Riley lies within a transitional zone between deciduous forests of Eastern Kansas and the grass prairies of the Great Plains. The area supports a wide variety of wildlife, adapted to a variety of habitat types. Habitats at Fort Riley consist of a mosaic of upland and riparian woodland, cropland, tall grass prairie, pasture/hayfield, re-vegetated grassland, and lawn based upon previous work performed. The Kansas River provides additional wildlife habitat.

The Fort Riley PWE Conservation Branch has identified 28 listed and rare species that have been identified or could potentially exist in the Fort Riley area. A list of theses species is provided on Table 2-1. Many of the species have recently been documented at Fort Riley.

According to the National Wetland Inventory (NWI) maps, one palustrine scrub-shrub wetland is located on the south bank of the Kansas River and three seasonally or temporarily flooded riverine wetlands are located on the north bank of the Kansas River.

2.4 SITE HISTORY

Fort Riley was established in 1853 and has been owned and operated by the DA since that time. The Camp Funston cantonment area, where the CFI Site is located, was constructed during the summer of 1917 as part of the WWI war effort and has been occupied and in service continuously since.

There is currently no information available on the date the CFI was constructed or how long incinerator operations were ongoing. The CFI Site was operational during World War I; however, it is believed that the CFI operations ceased within a year after the end of WWI. Camp Funston maintained its own garbage collection, disposal system, and incinerators for the disposal of the waste stream. The Camp Funston waste stream consisted of garbage, similar to that of a small municipality of its time, and dead animals. The waste stream during peak operation was approximately 18,000 pounds per day. The CFI was operated by the burning of wood; however, it is not known whether or not combustible fuels were used as accelerant to support the CFI operations. The CFI byproducts (ash/cinders) were dumped and/or pushed over the edge of the upland terrace onto the floodplain slope. During the 2010 field investigation activities, both the brick and mortar incinerator foundation and the concrete incinerator pad were demolished.

2.5 ENVIRONMENTAL INVESTIGATION HISTORY

Several environmental investigations have been conducted at the CFI Site including:

- A field investigation was conducted in early 2000 by Arrowhead Contracting, Inc. ([Arrowhead], 2001). This investigation was performed to determine whether shallow soils at and adjacent to the foundation of the CFI were impacted by heavy metals contamination.

- In December 2006, the USACE-CENWK performed additional soil sampling, to follow up the 2000 field investigation, at the CFI Site (USACE-CENWK, 2007). The objectives of this investigation were to verify the results from the x-ray fluorescence (XRF) investigation conducted in 2000 and to determine the distribution of metals arising from the previous use of the incinerator.

- In 2010, CTI performed additional soil sampling at the CFI Site. In addition, CTI performed demolition, removal, and off-site disposal of the incinerator foundation and contaminated upland surface soil as special waste (CTI, 2010).

Appendix A contains complete copies of all of the above mentioned reports. More detailed information and sample results of the previous environmental investigations are presented in Section 6.2 of this RI/FS WP.

* * * * *

3.0 INITIAL EVALUATION

3.1 INTRODUCTION

The purpose of this section of the RI/FS WP is to present an initial evaluation of the CFI Site. This evaluation provides a foundation for the development of project objectives and indicates data requirements to be addressed during the RI/FS process. It includes the development of a CSM, a review of potential ARARs, and the identification of preliminary RAOs, potential RAAs and GRAs. This evaluation takes into consideration the results of the previous environmental investigations detailed in Section 6.3. Copies of the historical environmental investigations conducted at the CFI Site are provided in Appendix A.

3.2 COPC SELECTION RATIONALE

The rationales for the selection of the COPCs at the CFI Site for this RI are based upon historical operations, incinerator practices, and the results of the previous environmental investigations. The selection rationales for the COPCs are as follows:

- Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) were selected due to the possibility that hydrocarbons may have been used as a fuel source at the CFI facility during its operation. Currently there is virtually no information available on the historical operations or practices at the CFI facility.

- Total Petroleum Hydrocarbons (TPH) – Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) were selected due to the possibility that hydrocarbons may have been used as a fuel source at the CFI facility during its operation. Currently there is virtually no information available on the historical operations or practices at the CFI facility.

- Target Analyte List (TAL) metals (23 elements) were selected based on their presence in the soil and ash/cinder deposits in previous environmental investigations at the CFI Site. Additionally, metals compounds are a common byproduct from the combustion process and tend to concentrate in incinerator waste materials such as ash/cinder and particulates.

- Methyl Mercury (MeHg) was selected due to the possibility of these compounds being formed from the combustion process at the CFI facility during its operation.

- Semi-Volatile Organic Compounds (SVOCs) (phenols and polycyclic aromatic hydrocarbons [PAHs]) were selected due to the possibility of these compounds being formed from the combustion process at the CFI facility during its operation.

- Dioxins/furans were selected due to the possibility of these compounds being formed from the combustion process at the CFI facility during its operation.

The COPCs mentioned above are tentative and will be adjusted as the investigation(s) at the CFI Site move forward.

3.3 COPCs

The COPCs for the CFI Site and their matrices are presents below.

Matrix	BTEX	TPH-GRO	TPH-DRO	TAL Metals	MeHg	SVOCs	Dioxins/Furans
Surface Soil	X	X	X	X	X	X	X
Subsurface Soil	X	X	X	X	X	X	X
Stream Sediment	X	X	X	X	X	X	X
Surface Water	X	X	X	X	X	X	X
Groundwater	X	X	X	X	X	X	X

3.4 CSM

A CSM is developed to establish a current understanding of the CFI Site conditions. Thus, it is based on the current understanding of releases at the CFI, as they may contribute to potential human health and ecological impacts in the area, and is presented to focus on those sources, environmental migration pathways, exposure areas, and potential receptors that require further evaluation. The CSM includes the following components:

- Potential Contaminant Sources;

- Release and Transport Mechanisms;
- Affected and Exposure Media;
- Possible Exposure Routes;
- Potential Human Receptors; and
- Potential Ecological Receptors.

These components are discussed in the following six subsections.

3.4.1 Potential Contaminant Sources

The potential contamination sources for the CFI Site associated with the historical operations include ash/cinder direct disposal, particulate deposition from incinerator emissions, and incinerator fuel source releases. Previous environmental investigations at the CFI Site indicate that soils down-slope (southeast) from the CFI are impacted by metals contamination.

3.4.2 Release and Transport Mechanisms

The potential for contaminants to be released and migrate from an affected area or medium is dependent upon the following three factors:

- The physical and chemical properties of the contaminants;
- The environmental processes affecting them; and
- Media characteristics through which the contaminants may migrate.

Physical and chemical properties of each COPC include water solubility, vapor pressure, Henry's Law Constant, partitioning behavior, and transformation and degradation rates. These properties help predict possible release and transport mechanisms. Appendix B includes a description of these physical and chemical characteristics.

Environmental processes include physical, chemical, and biological processes occurring within or between environmental media. Soil erosion and particle transport, volatilization, wind erosion and atmospheric deposition, particulate deposition, leaching, partitioning, groundwater advection, dispersion and diffusion, and transformations such as hydrolysis, oxidation, photolysis, and microbial degradation may all affect the distribution, persistence, and fate of chemicals.

Site-specific factors may affect migration potential. Factors such as climatic conditions (*e.g.,* rainfall, temperature, wind), hydrological conditions (depth to groundwater, groundwater flow direction and rate, presence and nature of surface water), and soil properties (type, porosity, permeability, temperature, moisture, organic content) each contribute to migration potential.

Three primary release mechanisms during operation and four transport mechanisms for the CFI Site can be identified. These include the direct disposal of ash/cinder waste from incinerator operations, particulate deposition from incinerator emissions to soil and surface water, and incinerator fuel source releases due to leaks and/or spills. The transport mechanisms include leaching from soil to groundwater with subsequent lateral migration in groundwater, surface runoff of stormwater across the CFI Site into Threemile Creek, fugitive dust generated from the direct disposal of ash/cinder waste, and volatilization of BTEX and petroleum hydrocarbons from soil and groundwater to air. In general, physical and chemical properties of BTEX and petroleum hydrocarbons allow these contaminants to both volatilize to air and migrate through soil and groundwater. Because of cation exchange and sorption onto the surface of mineral grains, metals typically have a fairly limited mobility in soil and groundwater. However, certain conditions, such as low pH, can result in increased mobility of metals. SVOCs (phenols and PAHs) and dioxins/furans also have limited mobility in soil and groundwater, as they tend to sorb onto organic matter within soil and are water insoluble. The presence of high concentrations of petroleum or solvents can increase their solubility and thus increase their mobility in soil and water.

3.4.3 Affected Media and Exposure Media

Since the CFI Site has not been under operation for approximately 95 years, and deposition from soil to air has already occurred, the current primary medium affected by historical operations at the CFI Site is soil. Groundwater, surface water, sediment, and air are secondary-affected media. There is potential that groundwater has or could be affected by the potential of leaching form soil to groundwater with the possible subsequent lateral migration in groundwater. Surface water and sediment are currently affected due to the runoff of storm water. Historically, surface water and sediment were affected due to runoff of storm water, particulate deposition from incinerator emissions, and fugitive dust generated from the direct disposal of ash/cinder waste. Air is currently affected due to the potential for volatilization of BTEX and petroleum hydrocarbon compounds from soil to air. Historically, air was affected due to fugitive dust generated from the direct disposal of ash/cinder waste. Exposure to one or more of these affected media is possible, depending on the area and receptor.

3.4.4 Possible Exposure Routes

An exposure route is the mechanism by which receptors come into contact with chemicals. Exposure routes for human and ecological receptors typically include one or more of the following: ingestion, inhalation, and dermal contact. Potential exposure routes will be evaluated in the Pathways Analysis Report (PAR) and BLRA (see Sections 5.10 and 5.11, respectively). Specific routes that will be examined in more detail are described in the sections below.

3.4.4.1 Air Exposure Routes

Exposure to chemicals in air through inhalation may occur if fugitive dust is generated at the CFI Site or if chemical vapors migrate from the subsurface to outdoor air. Most of the CFI Site is wood/brush covered unoccupied land. Earthwork, brush clearing activities, and/or future excavation work may increase exposure opportunity. Therefore, the air exposure routes will be evaluated further in the PAR and BLRA.

3.4.4.2 Soil and Stream Sediment Exposure Routes

Human contact with chemicals in soil and stream sediment may occur through ingestion, dermal contact, or inhalation of dust or volatilization of chemicals. Ecological receptors may contact chemicals in soil and stream sediment by ingestion, dermal contact, or root uptake. Additional surface and subsurface soil sampling and sediment sampling is planned during the RI/FS activities to delineate the extent of soil contamination and to evaluate these potential exposure routes.

3.4.4.3 Groundwater Exposure Routes

Typically human exposure routes to chemicals in groundwater include ingestion, dermal contact, and inhalation of volatile organics. Ingestion and dermal contact of impacted groundwater is not likely because there are no potable wells located at or near the CFI Site and none are likely to be installed in the future; however, if groundwater is of sufficient yield (minimum 150 gallons per day [gpd]) and quality (total dissolved solids [TDS] less than 1,200 milligrams per liter [mg/L]) that it does not meet the KDHE requirements for excluding the potable water pathway, it will be considered. Excavation into groundwater at the CFI Site is unlikely because of its anticipated depth of approximately 25 ft bgs. Inhalation of vapors remains a potential route for human exposure to impacted groundwater at the CFI Site. Root uptake is a possible but unlikely potential exposure for terrestrial flora due to the depth of groundwater. Groundwater sampling is planned during the RI/FS activities to delineate the extent of groundwater contamination and to evaluate the potential exposure routes.

3.4.4.4 Surface Water Exposure Routes

Chemicals may be transported into surface water systems via erosion of surface soils and sediments, leaching of contaminants directly to surface water, or discharge of groundwater to surface water. Direct surface water exposures from Threemile Creek flow and/or overland flow of stormwater at the CFI Site are possible. Groundwater flow into the Kansas River alluvium could introduce contaminants to the Kansas River. For human receptors, exposure routes to chemicals in surface water may include ingestion, dermal contact, and inhalation of vapors. For environmental receptors, exposure routes may include ingestion and dermal contact for fauna and root uptake and leaf sorption for flora. These surface water exposure routes will be further evaluated in the RI/FS activities.

3.4.4.5 Food Chain Transfer Exposure Routes

Humans may become exposed to contaminants through consumption of plants and/or animals that have been exposed to contaminants. There are no agriculture land uses at or near the CFI Site thereby limiting the potential for crop or animal uptake to occur. The most likely scenario for human exposure via food chain transfer is consumption of fish from Threemille Creek or wild game from the CFI Site. Groundwater migration potential to Threemile Creek and the Kansas River and the subsequent potential exposure routes will be evaluated in the RI/FS activities.

3.4.5 Potential Human Receptors

As discussed in Section 2.3.7, the current and future land use at the CFI Site is classified, by the Fort Riley RPMP, as open space (Black & Veatch, 2007). The area in the immediate vicinity of the CFI Site is currently unused wood/brush-covered land. Building 1460 located approximately a half mile east of the CFI Site is used for the repair, maintenance, and storage of vehicles and heavy equipment. There is an active fire station approximately a half mile northeast of the CFI Site on Huebner Road. There is active military housing (barracks) approximately a half mile northwest of the CFI Site on Huebner Road. The Camp Funston Wastewater Treatment Plant is located approximately a quarter mile south of the CFI Site. The former Southwest Funston Landfill lies approximately a half mile south of the CFI Site. The UPRR tracks, which run immediately northwest of the CFI Site, support moderately heavy rail traffic, with several freight trains both east and westbound each day. Future land use at the CFI Site is likely to remain the same; however, during the BLRA, all land use scenarios will be considered based upon current land use near the CFI Site as discussed above.

Potential receptors are defined as the human or ecological populations that may be exposed to chemicals in an exposure medium through one or more exposure routes. This is described as a complete exposure pathway and must have the following essential components: site-related chemical release to environment;

transport to an exposure point; the presence of a receptor at the exposure point; and an exposure route. The following is a discussion of human and ecological receptors for which potentially complete exposure pathways may exist currently or in the future, in the absence of remediation. The plausibility of these receptors and others presently unidentified will be evaluated in the PAR and BLRA.

Potentially exposed human populations include those persons whose locations and activities create an opportunity for contact with impacted media. Site conditions, land, and water uses influence human activities and patterns of behavior and are considered in identifying potential receptors. It should be noted that not every receptor is likely to be present or contact all exposure media. The human receptors that may be evaluated quantitatively are anticipated to include future residents, future site workers, future construction workers, current and future youth visitors (6 to 15 years of age), and current and future adult visitors (15 years of age and up). Potentially completed exposure pathways for the anticipated human receptors are displayed on Figure 3-1 and described below; however, one or more pathways may be determined to be incomplete based on the results of the proposed field activities.

Future Residents

The potentially completed exposure pathways for future residents are:

- Incidental ingestion of surface soil;
- Absorption through dermal contact with surface soil;
- Inhalation of fugitive dust;
- Inhalation of outdoor vapors from soil and/or groundwater;
- Incidental ingestion of stream sediment;
- Absorption through dermal contact with stream sediment;
- Incidental ingestion of surface water;
- Absorption through dermal contact with surface water;
- Inhalation of vapors from surface water;
- Inhalation of vapors from groundwater as potable water source;

- Ingestion of groundwater as a drinking water source; and
- Dermal contact with groundwater as a drinking water source.

Future Site Workers

The potentially completed exposure pathways for future site workers are:

- Incidental ingestion of surface soil;
- Absorption through dermal contact with surface soil;
- Inhalation of fugitive dust;
- Inhalation of outdoor vapors from soil and/or groundwater;
- Incidental ingestion of stream sediment;
- Absorption through dermal contact with stream sediment;
- Incidental ingestion of surface water;
- Absorption through dermal contact with surface water;
- Inhalation of vapors from surface water;
- Inhalation of vapors from groundwater as potable water source;
- Ingestion of groundwater as a drinking water source; and
- Dermal contact with groundwater as a drinking water source.

Future Construction Workers

The potentially completed exposure pathways for future construction workers are:

- Incidental ingestion of surface and subsurface soil;
- Absorption through dermal contact with surface soil;
- Inhalation of fugitive dust;

- Inhalation of outdoor vapors from soil and/or groundwater;
- Incidental ingestion of stream sediment;
- Absorption through dermal contact with stream sediment;
- Incidental ingestion of surface water;
- Absorption through dermal contact with surface water;
- Inhalation of vapors from surface water; and
- Ingestion of groundwater as a drinking water source.

Current and Future Youth (6 to 15 years of age) and Adult (15 years of age and up) Visitors

The potentially completed exposure pathways for current and future youth and adult visitors are:

- Incidental ingestion of surface soil;
- Absorption through dermal contact with surface soil;
- Inhalation of fugitive dust;
- Inhalation of outdoor vapors from soil and/or groundwater;
- Incidental ingestion of stream sediment;
- Absorption through dermal contact with stream sediment;
- Incidental ingestion of surface water;
- Absorption through dermal contact with surface water;
- Inhalation of vapors from surface water;
- Inhalation of vapors from groundwater as potable water source;
- Ingestion of groundwater as a drinking water source; and
- Dermal contact with groundwater as a drinking water source.

3.4.6 Potential Ecological Receptors

As a minimally maintained area, terrestrial vegetation, invertebrates, and small mammals at the CFI Site may be considered potential receptors and will be evaluated in the BLRA. It is a goal to restore or maintain areas within the terrestrial area as natural systems or as ecological habitats. Additionally, ephemeral drainage areas show evidence of potential aquatic communities when water is pooled. The receptor pathways and risk associated with these areas will be evaluated in the BLRA. Chemical uptake via food webs and chains will be further discussed in the BLRA Report. The ecological risk assessment will follow USEPA, 1998, *Guidelines for Ecological Risk Assessment*, EPA/630/R-95/002F and all other applicable USEPA guidance; and be complete enough to support a high-medium-low qualitative ecological risk assessment. The ecological receptors that may be evaluated quantitatively are anticipated include soil invertebrates, benthic and aquatic invertebrates, terrestrial plants, aquatic plants, aquatic vertebrates, terrestrial herbivores, terrestrial omnivores, and terrestrial carnivores. However, completed pathways identified in the preliminary ecological CSM (Figure 3-2) may be determined to be incomplete based on the conditions observed in the field or due to a lack of suitable potential receptor habitat.

3.5 PRELIMINARY IDENTIFICATION OF ARARs and TBCs

The NCP provides that the lead agency will identify all ARARs based upon an objective determination of whether the requirement specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site [40 Code of Federal Regulations (CFR) 300.400(g)].

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitation promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site [40 CFR 300.400(g)(4)]. During review of a potential ARAR, it is first determined whether that ARAR is applicable. If it is not legally applicable, it may still be binding as an ARAR if it is found to be relevant and appropriate. It is important to note that if a state is authorized to implement a program in lieu of a federal agency, state laws arising out of that program constitute the ARARs instead of the federal authorizing legislation (USEPA, 1989, 1991, 2004, and 2009a). Only state regulations that are promulgated, more stringent than federal regulations, and identified in a timely manner are potential ARARs.

To consider whether a non-applicable requirement is *relevant and appropriate*, comparisons of a number of site-specific factors are performed in light of standards, criteria, protective requirements, or limitations that are promulgated under federal or state law that are not legally applicable, but which address problems

or situations sufficiently similar to those encountered at the CFI Site. A requirement may be relevant if it addresses problems or situations sufficiently similar to the circumstances of the release or remedial action contemplated; it may also be appropriate if it is well-suited to application at the CERCLA site in question. If it is not both relevant and appropriate, it is not adopted as an ARAR. It is possible for a portion of a requirement to be relevant and appropriate, while other parts are not appropriate for site-specific circumstances.

Comparison between the non-applicable requirements and the site conditions in question are made according to following criteria as presented in the NCP (40 CFR 300.400(g)(2):

- The purpose of the requirements and the purpose of the CERCLA action;
- The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- The substances regulated by the requirements and the substances found at the CERCLA site;
- The actions or activities regulated by the requirements and the remedial action contemplated at the CERCLA site;
- Any variance, waivers or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- The type of place regulated and the type of place affected by the release of CERCLA action;
- Type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource [40 CFR 400(g)(2)(I) through (viii)] at the CERCLA site.

Other information that does not qualify as an ARAR may be needed during the development of remedies. This information referred to as TBC information consists of non-promulgated advisories, criteria, or guidance issued by federal, state, or local government agencies that are not legally binding and do not have the status of potential ARARs and site-specific risk assessments. TBC information generally falls within three categories:

- Health effects information with a high degree of credibility;

- Technical information on how to perform or evaluate site investigations or response actions; and
- Regulatory/administrative agency policies.

While they do not carry the weight of potential ARARs and site-specific risk assessments in the determination of remedial goals, TBCs may considered in conjunction with ARARs and site-specific risk assessments during the CERCLA process when developing remediation goals and/or in developing remedies. TBCs for the CFI Site will be considered along with ARARs and the site-specific risk assessments and may be used in determining the necessary level of cleanup for protection of human health and the environment at the CFI Site. It is imperative that TBCs be applied in the context that they were developed and their inherent assumptions may not apply to the CFI Site.

The following sections identify potential ARARs to assist in the development of potential remedial alternatives and remediation goals. Under CERCLA guidance, ARARs are categorized as chemical-specific, location-specific, and/or action-specific. ARARs that are eventually applied will be dependent upon the nature of the site, and the selected RAAs.

3.5.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are usually health-based or risk-based numerical values which, when applied to site conditions, result in establishment of numerical action values. These values establish the acceptable amount or concentration of a chemical in a medium or discharge stream. Potential chemical-specific ARARs are generally applied to contaminants in a specific medium, such as soils, surface waters, stream sediments, and groundwater.

The potential chemical-specific ARARs for the site include:

- Kansas Water Pollution Control (KWPC) [Kansas Administrative Regulations (K.A.R.) § 28.16.1 to 28.16.154];
- National Primary Drinking Water Regulations and Implementation [40 CFR § 141 and 142];
- Federal Ambient Water Quality Criteria [40 CFR § 131];
- Clean Water Act (CWA) [33 United States Code (USC) § 1251 to 1375];
- Clean Air Act (CAA) [42 USC § 7401to 7671, 40 CFR § 50 and 61]; and
- USEPA Maximum Contaminant Levels (MCLs) [USEPA, May 2009b].

3.5.2 Potential Location-Specific ARARs

Location-specific ARARs are requirements or restrictions placed on the concentrations of a hazardous substance or the conduct of activities at a site solely because they are in a specific geographic location. Federal and state location-specific ARARs include those established to protect endangered species, fish and wildlife, surface water quality, wetlands, water wells, floodplains, cultural resources, and air quality.

The potential location-specific ARARs for the CFI Site include:

- Kansas Nongame and Endangered Species Conservation Act of 1975 and
- Kansas Historic Preservation Act [Kansas Statute Annotated (K.S.A.) § 75.2715 to 75.2725].

3.5.3 Potential Action-Specific ARARs

Action-specific ARARs are technology-based or activity-based requirements or limitations triggered by proposed remedial actions for the site. Since there are often several alternative remedies being considered for a given site, very different requirements can be considered. Action-specific ARARs will be determined following selection of a remedial action, if required.

Potential action-specific ARARs include the following:

- CWA [33 USC § 1251to 1375];
- National Pollutant Discharge Elimination System (NPDES) [40 CFR § 122];
- Safe Drinking Water Act (SDWA) [42 USC § 201 and 301];
- KWPC [K.A.R. § 28.16.1 to 28.16.154];
- Kansas Wastewater Discharge Control [K.S.A. § 65.161];
- CAA [42 USC § 7401 to 7671, 40 CFR § 50 and 61];
- Kansas Ambient Air Quality Standards and Air Pollution Control Regulations [K.A.R. 28.19];
- Resource Conservation and Recovery Act (RCRA) [42 USC § 6901 to 6992];
- Transportation: Hazardous Materials Regulations [49 CFR § 171 to 173];
- Protection of Wetlands [Executive Order 11990, 40 CFR § 6.302];

- Kansas Hazardous Waste Management Standards and Regulations [K.A.R. § 28.31];
- Kansas Solid Waste Management Standards [K.A.R. § 28.29];
- Kansas Underground Injection Control Regulations [K.A.R. § 28.46];
- Kansas Spill Notification [K.A.R. § 28.48.1];
- Prevention of Water Pollution [K.S.A. § 65.171d];
- Cleanup Operations [K.S.A. § 65.171v];
- National Emission Standards for Hazardous Air Pollutants [40 CFR, Part 61];
- Plans for Designated Facilities and Pollutants [40 CFR, Part 62];
- Generation of Hazardous Waste [40 CFR, Part 262]; and
- Hazardous Waste Treatment, Storage, and Disposal [40 CFR, Part 264].

3.5.4 Potential TBCs

As stated above, TBCs are non-promulgated advisories, criteria, or guidance issued by federal, state, or local government agencies that are not legally binding and do not have the status of potential ARARs and site-specific risk assessments. Potential TBCs that may be used to in the CERCLA process for the CFI Site include:

- KDHE RSK Manual 5th – Version [KDHE, October 2010];
- USEPA Regional Screening Levels (RSLs) Summary Table [USEPA, May 2013];
- Threshold Effect Concentrations (TECs) as presented in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al., January 2000);
- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) [NOAA, November 2008]; and
- USEPA National Recommended Water Quality Criteria, Human Health Criteria Table (USEPA, January 2013a).

It is imperative that the TBCs listed above be applied in the context that they were developed and their inherent assumptions may not apply to the CFI Site.

3.6 PRELIMINARY RAOs

RAOs provide the basis for the development of remedial alternatives. RAOs consist of medium-specific goals for protecting human health and the environment from risks posed by a site. RAOs specify media of interest, contaminants of interest, and preliminary remediation goals (PRGs) that permit a range of treatment and containment alternatives to be developed and evaluated. Acceptable contaminant levels or ranges of levels for each exposure route can be identified. RAOs are developed on the basis of chemical-specific ARARs and site-specific risk-related factors. Preliminary RAOs are developed during scoping of the RI/FS to assist in identifying potential remedial alternatives and RI data requirements. Preliminary RAOs are based on the existing data for a site and the CSM.

Preliminary RAOs are dynamic and may be refined throughout the site characterization and BLRA processes. RAOs for other media can also be developed if RI data indicates additional media of concern. Media-specific screening levels and the hierarchy in which they will be used throughout the RI/FS process are discussed in Section 4.2.5. Preliminary RAOs by medium include the following:

Soil RAOs

- Prevent or minimize exposure to soils containing COPCs exceeding ARARs or risk-based levels and

- Control further releases of contaminants to prevent leaching to groundwater which results in groundwater contaminant levels above ARARs or risk-based levels.

Stream Sediment RAOs

- Prevent or minimize exposure to sediments containing COPCs exceeding risk-based levels and

- Control further releases of contaminants to prevent or minimize further spread or migration of contaminants via surface runoff which results in stream sediment contaminant levels above ARARs or risk-based levels.

Surface Water RAOs

- Prevent or minimize exposure to surface water containing COPCs exceeding ARARs or risk-based levels and

- Control further releases of contaminants to prevent direct discharge to water bodies and surface runoff which results in surface water contaminant levels above ARARs or risk-based levels.

Groundwater and Saturated Soil RAOs

- Prevent or minimize exposure to groundwater and dermal contact with groundwater containing COPCs exceeding ARARs or risk-based levels and

- Control further releases of contaminants to prevent or minimize further spread or migration of contaminants via leaching which results in groundwater and saturated soil contaminant levels above ARARs or risk-based levels.

PRGs are used in the FS in the evaluation of remedial alternatives. Final remedial goals are established during final remedy selection and can be changed at a later time if more appropriate standards are adopted by the regulatory community or if it is found that technical limitations preclude achieving the goals.

3.7 POTENTIAL RAAs

In planning the FS, a preliminary range of RAAs and associated technologies are identified. The preliminary alternative and technology identification process consists of a general classification of potential remedial actions based on the initially identified potential routes of exposure and associated receptors. Identification of potential remedies at this stage of the project is useful to aid in determining the site data needed to evaluate remedial alternatives and to allow early determination as to the need for treatability studies.

The first step in identifying potential remedial alternatives is to define GRAs for the CFI. GRAs are actions that broadly define the nature of the response. The GRA categories will be considered in the remedy selection during the comparative analysis of alternatives consistent with NCP § 300.430(e)(9). As with RAOs, GRAs are also medium-specific. Based on data currently available, a preliminary identification of GRAs for each medium has been completed.

Potential actions for soil include the following:

- Institutional Controls;

- Containment;

- In-Situ Treatment; and

- Excavation and Off-Site Disposal.

Potential actions for surface water include the following:

- Institutional Controls;
- Containment;
- In-Situ Treatment;
- Extraction/Discharge; and
- Extraction, Ex-Situ Treatment, and Discharge.

Potential actions for stream sediment include the following:

- Institutional Controls;
- Containment;
- In-Situ Treatment; and
- Excavation and Off-Site Disposal.

Potential actions for groundwater and saturated soil include the following:

- Institutional Controls;
- Natural Attenuation;
- Containment (plume control);
- In-Situ Treatment;
- Extraction/Discharge; and
- Extraction, Ex-Situ Treatment, and Discharge.

Potential actions for air include the following:

- Institutional Controls;

- Dust Controls;
- Extraction/Discharge; and
- Containment.

The GRAs defined above will be refined throughout the RI/FS process as a better understanding of the CFI Site is gained. Following completion of the RI, the complete process of development and analysis of RAAs will be performed in the FS as discussed in Section 5.0 of this RI/FS WP.

* * * * *

4.0 WP RATIONALE

4.1 INTRODUCTION

The purpose of this section is to present the RI/FS WP rationale for the CFI Site. The rationale provides the bridge between the initial evaluation in Section 3.0 and the RI/FS SOW in Section 5.0. This section develops the Data Quality Objectives (DQOs) and identifies data needs for characterization, risk assessment, and remedial alternatives evaluation. The WP approach is presented to demonstrate how data needs will be satisfied during the RI/FS.

4.2 DQOs

DQOs are qualitative and quantitative statements that clarify study objectives, define the type of data needed, and establish error limits for the quality and quantity of data needed to support decisions. DQOs are used to establish performance criteria, or measurement quality objectives, that take into account the purpose of data collection, the types of data needed, and tolerable limits for making decision errors (USEPA, 2006). DQOs are developed through the following seven-step process:

- Step 1: State the Problem;
- Step 2: Identify the Goals of the Study;
- Step 3: Identify Information Inputs;
- Step 4: Define the Study Boundaries;
- Step 5: Develop the Analytic Approach;
- Step 6: Specify Performance or Acceptance Criteria; and
- Step 7: Develop the Plan for Obtaining Data.

DQOs are revised and/or expanded, as needed, based on review of each data collection and analysis activity. Over the course of the investigation, it is anticipated that these DQOs will be revisited and adjusted as information not available at project outset is used to assist in their refinement. Site-specific information for the CFI Site is presented in the next section of this RI/FS WP. The following sections present a discussion of DQO development.

4.2.1 DQO Step 1: State the Problem

The primary objective of the RI/FS is to conduct environmental investigation actions necessary to define the nature and extent of contamination to achieve remedy in place (RIP) or closure status. Fort Riley has determined that a comprehensive investigation of surface soil, subsurface soil, stream sediment, surface water and groundwater is required at the CFI Site.

4.2.2 DQO Step 2: Identify the Goals of the Study

The purpose of this step is to identify the questions that this investigation will address. The primary goals are to identify the key questions(s) of the study; define alternative actions that could result from resolution of the study question(s); and combine the study questions and alternative actions into decision statement(s) (USEPA, 2006). The following key questions will need to be answered during the investigation to meet the project objectives.

Key Question	Alternative Actions
Has the nature and extent of on-site contamination been adequately defined by previous investigations?	If the data is sufficient, additional data collection will not be necessary. If the data is insufficient, additional data collection will be performed.
Has the nature and extent of off-site contamination been adequately defined by previous investigations?	If the data is sufficient, additional data collection will not be necessary. If the data is insufficient, additional data collection will be performed.
Have the physical characteristics of the site been adequately characterized, including fate and transport mechanisms?	If the physical/geotechnical/geochemical data collection is sufficient, additional data collection will not be necessary. If the physical/geotechnical/geochemical data collection is not sufficient, additional data collection will be necessary.
Is additional information needed for evaluation of remedial alternatives in the FS?	If additional data is needed, the type and quantity will be determined and collected. If existing information is sufficient, additional data collection will not be necessary.

4.2.3 DQO Step 3: Identify Information Inputs

Step 3 identifies information that is needed to support the decision statements made in Section 4.2.2 and also identifies areas that will require environmental data collection. To adequately address the decision statements the following types of input are needed:

Information Needs

An evaluation of existing data has been performed to identify potential data gaps for the CFI Site. Additional data needs for the CFI Site include:

- Additional samples to determine the nature and extent of contamination both on-site and off-site;
- Additional data to physically characterize the CFI Site; and
- Additional data to evaluate remedial alternatives for the CFI Site.

This additional data is needed to determine nature and extent of contaminants present, evaluate fate and transport of the contaminants, characterize risk to human health and the environment, evaluate the need for remediation, determine remediation methods, and design remediation systems. Details of the existing data and data gaps are presented in Section 6.0 of this RI/FS WP.

4.2.4 DQO Step 4: Define the Study Boundaries

Step 4 clarifies the characteristics that the collected environmental data are intended to represent. The following seven activities are performed to define the study boundaries: 1) define the population of interest; 2) define the geographic area; 3) divide the population into relatively homogeneous strata; 4) determine the time frame to which the decision applies; 5) determine the data collection time frame; 6) define the scale of decision making; sampling and analysis considerations; and 7) identify any constraints on the data collection. The following paragraphs address each of these items.

Population of Interest

Surface and subsurface soil, stream sediment, surface water, and groundwater are the media of interest for this RI/FS. The nature and extent of contamination related to the operations of the CFI will be investigated. In addition, the contamination will be delineated horizontally and vertically at the CFI Site.

Geographic Area

The geographic area under consideration is the CFI Site. Figure 2-3 provides a map with the CFI Site location.

Site Investigation Media of Interest

The media of interest for the CFI Site includes the following:

- Background surface and subsurface soils from an off-site location analogous to the CFI Site;
- Surface and subsurface soils from the upland terrace area, the floodplain slope, and the Kansas River floodplain at the CFI Site; and
- Surface soils from the overland flow area.

- Stream sediments from Threemile Creek at, up-gradient of, and down gradient locations from the CFI Site;
- Surface waters from Threemile Creek at, up-gradient of, and down gradient from the CFI Site; and
- Groundwater at and down gradient from the CFI Site.

Time Frame

The project schedule is presented in Section 7.0 of this RI/FS WP.

Scale of Decision Making

The most appropriate scale for each media of interest was determined to be as follows:

- Surface and Subsurface Soil – Surface and subsurface soils will be considered separately;
- Stream Sediment – Sediments will be considered separately;
- Surface Water – Surface waters will be considered separately;
- Groundwater – Groundwater will be considered separately.

Sampling and Analysis Considerations

Samples will be collected in a manner as to ensure comparability of the data. Samples for chemical analysis will be submitted to a certified off-site laboratory for testing using methods from USEPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Update IV of the Third Edition* (i.e., SW-846) (USEPA, 2009c). The selected laboratories will be accredited by the United States Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP).

Constraints on Data Collection

Sampling may be delayed by excessive periods of precipitation that would limit accessibility to the CFI Site. Refusal during drilling and direct-push activities due to subsurface obstacles may limit the ability to collect samples at a given location. The steepness of the floodplain slope may limit the accessibility of direct-push rigs. The presence of utilities may also limit sample locations.

4.2.5 DQO Step 5: Develop the Analytical Approach

In Step 5, an approach is developed that will guide analysis of the data. A decision rule is developed that defines the conditions that would cause the decision maker to choose among alternative actions. Activities involved in Step 5 include the following:

Medium Measurement/Statistical Parameter

Different data uses will result in the potential need to examine multiple statistical parameters for a given medium and/or location. Depending on the end use of the data (i.e., source identification, determination of extent of contamination, risk assessment, etc.), any one of several statistical parameters could prove useful. For example, the use of the maximum concentration of a constituent in a given medium is useful for identification of source areas. The difference between the maximum concentration of a constituent at an area boundary versus background can be used for definition of the extent of contamination. Similarly, risk assessors often use the mean or 95 percent upper confidence limit (UCL) of the concentrations of a constituent collected over a given area for purposes of their evaluation (see Section 5.9).

Screening Levels

Screening levels are used to determine the nature and extent of contamination and may subsequently serve as action levels for various activities. The following screening levels will be used during the RI/FS:

- KDHE RSK Manual – 5th Version (KDHE, October 2010);
- USEPA RSLs Summary Table (USEPA, May 2013b);
- USEPA Maximum Contaminant Levels (MCLs) (USEPA, May 2009b);
- TECs as presented in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al., January 2000);
- NOAA SQuiRTs (NOAA, November 2008)
- KDHE Kansas Surface Water Quality Standards, Tables of Numeric Criteria (KDHE, December 2004a); and
- USEPA National Recommended Water Quality Criteria, Human Health Criteria Table (USEPA, January 2013a).

Because the dynamic nature of screening standards, copies of each of the above mentioned screening standards are provided in Appendix C.

The following conventions will be used to evaluate the analytical data collected during this RI/FS:

Surface and Subsurface Soil

- USEPA RSLs for residential and industrial soil will be used as the soil/sediment screening level for all chemicals which have USEPA RSL screening values

- KDHE Soil Pathway RSKs for residential and non-residential scenarios will be used as the soil/sediment screening level for all chemicals which do not have KDHE RSK screening values.

Stream Sediment

Ecological

- Freshwater sediment TECs presented in the *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al., 2000) will be used as the stream sediment screening level as per the KDHE *Bureau of Environmental Remediation (BER) Assessment Restoration Section Sediment Policy*, BER Policy # BER-ARS-045 (KDHE, 2004b), for all chemicals which have TEC screening values in the above referenced document.

- NOAA SQuiRTs for freshwater sediment will be used as the stream sediment screening level for all chemicals which do not have *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* TEC screening values.

Human Health

- USEPA RSLs for residential and industrial soil will be used as the soil/stream sediment screening level for all chemicals which have USEPA RSL screening values.

- KDHE Soil Pathway RSKs for residential and non-residential scenarios will be used as the soil/stream sediment screening level for all chemicals which do not have KDHE RSK screening values.

Surface Water

- KDHE Surface Water Quality Standards (public health domestic water supply) will be used as the surface water screening level for all chemicals which have KDHE Surface Water Quality Standards (public health domestic water supply) screening values.

- USEPA National Recommended Water Quality Criteria, Human Health Criteria Table (human health for the consumption of water plus organism) will be used as the surface water screening level for all chemicals which do not have KDHE Surface Water Quality Standards (public health domestic water supply) screening values.

Groundwater

- USEPA MCLs will be used as the groundwater screening level for all chemicals which have USEPA MCL screening standards.

- USEPA RSLs for tapwater will be used as the groundwater screening levels for all chemicals which do not have USEPA MCL screening standards.

- KDHE Groundwater RSKs will be used as the groundwater screening level for chemicals which do not have USEPA MCL screening standards or USEPA RSL screening standards.

The most current and up-to-date screening levels, at the time of reporting, for all applicable screening criteria will be used throughout the RI/FS process.

Confirm Detection Limits

To the extent that it is technically feasible using routine analytical techniques, the reporting limits for critical parameters should meet the screening levels. The laboratories have been instructed to report any detected concentration between the Reporting Limit (RL) and Method Detection Limit (MDL) with an estimated result (J flag). In addition analytes should be reported from the analysis that has the lowest detection limit for that analyte without going over range. If a single analytes is over range all of the other analytes should be reported from the initial run with only the over range analyte being reported from the dilution.

Interference and/or elevated concentrations of target and non-target constituents could also necessitate sample dilution to mitigate these effects and minimize damage to laboratory instruments. This dilution could result in elevated reporting limits outside the control of the analytical laboratory. Therefore, automatic data rejection will not occur should a parameter's reporting limit exceed the screening value. Instead, the magnitude of the exceedence will be considered in conjunction with the intended use of the data to determine its overall impact upon decision making.

Decision Rule

Given the many objectives of the RI/FS, several decision rules may be appropriate for the project, as follows:

- Background soil data collected will be input into the most current USEPA ProUCL software. If the UCL for an analytical parameter is above background concentrations at the periphery of the CFI Site, the extent of contamination will require further evaluation; otherwise, further evaluation is not necessary. A single exceedance of a screening level or ARAR does not necessarily warrant remediation.

- If during the Phase I data evaluation an analytical parameter is not detected or is below its respective screening level (see Section 6.3.4), it will be excluded from further characterization during Phase II field activities at the CFI Site. Exceptions are considered when elevated reporting limits are encountered. In these situations, an evaluation of the feasibility of improving analytical performance will be made. A single exceedance of a screening level or ARAR does not necessarily warrant remediation.

- If the concentration of an analytical parameter exceeds ARARs for a given media, further evaluation will be required; otherwise, no further evaluation is necessary. A single exceedance of a screening level or ARAR does not necessarily warrant remediation.

- If the concentration of an analytical parameter is shown to pose unacceptable risk during the BLRA (see Section 5.9), further evaluation and/or remedial actions will be required; otherwise, no further evaluation is necessary. A single exceedance of a screening level or ARAR does not necessarily warrant remediation.

- If a remedial alternative is not able to achieve analytical parameter concentrations that are less than ARARs, further evaluation will be required; otherwise, no further evaluation is necessary but may be performed to assess other available options.

4.2.6 DQO Step 6: Specify Performance or Acceptance Criteria

In Step 5, an approach is developed that will guide analysis of the data. A decision rule is developed that defines the conditions that would cause the decision maker to choose among alternative actions. Performance criteria for decision rules are quantified by expressing the probability limits on potential errors in decision-making. The probability limits on decision errors specify the level of confidence desired in making conclusions regarding the data. The possibility of a decision study error exists due to

the inherent variability in the sample collection and analysis process. The two main components of the "total study error" include the following:

- Sampling Design Error – Sampling design error is influenced by the sampling design, the number of samples collected, and the inherent variability of the media to be sampled. Sampling design error occurs when the collection program does not account for the variability within the media.

- Measurement Error – Measurement error is influenced by the sampling and analysis system. Errors are introduced into the system during sample collection, handling, preparation, analysis, and data reduction.

"Total Study Error" can be controlled by hypothesis testing: that is, selecting the null hypothesis (H_0) and the alternative hypothesis (H_a) and testing to reject or accept H_0. The null hypothesis is the baseline condition that is presumed to be true in the absence of strong evidence to the contrary.

The null hypothesis and alternative hypothesis appropriate to the soil media (i.e., media) of this RI/FS WP include:

- H_0: Soils at the CFI Site do contain contaminants of concern with concentrations that exceed ARARs or the BLRA indicates unacceptable risk; and will need to be remediated.

- H_a: Soils at CFI Sites do not contain contaminants of concern with concentrations that exceed ARARs and the BLRA does not indicate unacceptable risk; and will not need to be remediated.

Similar hypothesis tests can be constructed for the groundwater, surface water, and stream sediment populations.

Two types of decision errors are common in environmental measurements. The first type of error is known as false rejection error, or Type I error. This occurs when the data lead the end user to conclude that the baseline condition (for example, the site is contaminated) is false when it is really true. The consequence of the false rejection error (Type I error) is that the contaminants of potential concern will not be remediated and will pose unacceptable risk to human health or the environment. False rejection errors (Type I errors) occur when the analytical data are biased low and/or exhibit non-detect results in error (i.e., false negative data). The second type of error is known as false acceptance error, or Type II error. False acceptance errors occur when the data lead the end user to conclude that the baseline condition (for example, the site is contaminated) is true when it is really false. The consequences of the false acceptance errors (Type II error) will be unnecessary expenditure of resources to remediate a site

that does not need remediation. False acceptance errors (Type II errors) occur when the analytical data are biased high and/or exhibit detections in error (i.e., false positive data). Because of the potential severity of the false rejection error (Type I error) consequences, the false acceptance error (Type II error) is more tolerable than the false rejection (Type I error).

To minimize the possibility of decision errors, the components of the total study error are examined. Sampling design error can be minimized by collecting a larger number of samples, or in the case of resource limitations, using screening technologies to focus sampling on areas of potential concern. Measurement errors can be minimized by replicate analysis of the same sample or by selecting cleanup, preparation, and analysis methods that are best suited to the site matrix. Measurement errors will be assessed by reviewing several data quality indicators (DQIs) including precision, accuracy, representativeness, completeness, and comparability as presented in the sampling and analysis plans (SAPs).

4.2.7 DQO Step 7: Develop the Plan for Obtaining the Data

The goal of DQO Step 7 is to develop a resource-effective design for collecting and analyzing samples and for generating other information needed to address the problem. The nature and extent of contamination as well as the fate and transport pathways have not been fully defined at the CFI Site. This RI/FS will provide data and information needed to address the identified data gaps. Specific sampling areas and analyses were selected using judgmental sampling based on the previous CFI Site investigations, discussions with BMcD chemists, and a visit to the CFI Site. The rationale for the sample collection activities and field requirements is outlined in the next section of this document.

The consequences of decision errors identified need to be balanced against the cost of limiting the possibility of these errors. Minimization of Type I and Type II errors requires large numbers of samples. To minimize additional data collection efforts for this RI/FS, the existing data and past historical knowledge were used to design the judgmental sampling scenario presented in Section 6.0 of this CFI Site. RI/FS sampling and analysis will have extensive quality assurance (QA)/quality control (QC) documentation to increase confidence in the data.

4.3 DATA NEEDS

An evaluation of existing data has been performed to identify potential data gaps for the CFI Site. Additional data needs for the CFI Site include:

- Background samples;

- Surface and subsurface soil samples;
- Stream sediment samples;
- Surface water samples;
- Groundwater samples;
- Vertical and horizontal delineation of groundwater contamination at the CFI Site;
- Installation of monitoring wells screened within the alluvial aquifer;
- Slug tests to evaluate hydrogeologic characteristics of the alluvial aquifer beneath the CFI Site; and
- Geochemical data including water quality parameters.

These data are needed to determine nature and extent of any contamination present, evaluate fate and transport of the contaminants, characterize risk to human health and the environment, evaluate the need for remediation, determine remediation methods, and design remediation systems. Details of the existing data and data gaps are presented in Section 6.0 of this RI/FS WP.

4.4 RI/FS WP APPROACH

The RI/FS WP approach was developed to satisfy the data needs identified in Section 4.3. This RI/FS WP has been written to support an iterative field approach for data collection. To ensure that the appropriate and needed amount of data is collected, this RI/FS WP is written to describe the two-phased approach of data collection and the decision processes for determining if additional data is needed for collection and where the data will be collected. The data needs for the CFI Site have been determined based upon historic operations, incinerator practices, and previous investigations. The two-phased sampling approach and Phase I data evaluation process is presented in Section 6.0 of this RI/FS WP. The detailed field and laboratory procedures are presented in detail in the Site-Specific Sampling and Analysis Plan (including Site-Specific Uniform Federal Policy [UFP] – Quality Assurance Project Plan [QAPP]) (SS-SAP) in Appendix C.

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5.0 RI/FS SOW

5.1 INTRODUCTION

This section presents the SOW necessary to complete the RI/FS for the CFI Site. Descriptions are provided for all RI/FS standard tasks including project plan preparation, field investigation activities, sample analysis/validation, data evaluation, risk assessment, RI Report preparation, remedial alternatives development/screening, detailed analysis of alternatives, and FS report preparation.

5.2 PROJECT PLANS

Specific procedures and guidelines for conducting the field activities are described in the Basic Documents for Environmental Investigations at Fort Riley, Kansas (Basic Documents). The applicable Basic Documents which are necessary to ensure successful completion of the RI/FS are listed below:

- ***Sampling and Analysis Plan, Installation-Wide, for Fort Riley CERCLA Process Support for Environmental Investigations at Fort Riley, Kansas*****,** (SAP-IW) (LBG-BMcD, 2011) – The SAP-IW establishes the policies, organization, objectives, functional activities, and specific QA/QC activities for managing projects on an installation-wide basis. The SAP-IW serves as an installation-wide document with general information pertinent to conducting field operations and investigations.

- ***Installation-Wide Accident Prevention Plan and Site Safety and Health Plan, for Environmental Investigations at Fort Riley, Kansas*** (IW-APP/SSHP) (LBG-BMcD, 2012) – The IW-APP/SSHP addresses installation-wide hazards and health and safety procedures to be followed during general environmental investigations at Fort Riley, including those for employee training, personal protective equipment usage, health surveillance, air monitoring, site security and control, decontamination, standard operating procedures (SOPs), and contingency planning.

- ***Installation-Wide Investigative-Derived Waste Management Plan, for Environmental Investigations at Fort Riley, Kansas,*** (IW-IDW) (BMcD, 2003) – The IW-IDW addresses the regulatory requirements, waste minimization, containerization, and disposal options of various types of investigative-derived waste (IDW) that could be generated during general environmental investigations at Fort Riley.

In addition to the Basic Documents, the following Site-Specific Documents will be used to implement activities outlined in this RI/FS WP:

- ***Quality Control Plan, for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*****,** (QCP) (LBG-BMcD, 2013a) – The QCP will ensure that the acceptability standards and criteria for this project and associated products are met. The QCP will identify intermediate and end products, and the critical stages of development for which the quality must be controlled to produce the required end products. The QCP will define the acceptability criteria for products and procedures, as well as define methods to be used to determine if the acceptability criteria have been satisfied.

- ***Site-Specific Investigative-Derived Waste Management Plan, for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*****,** (SS-IDW) (LBG-BMcD, 2013b) – The SS-IDW addresses site-specific regulatory requirements, waste minimization, containerization, and disposal options of various types of IDW that will be generated at the CFI Site.

- ***Site-Specific Sampling and Analysis Plan (Including Site-Specific UFP – Quality Assurance Project Plan), for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*****,** (SS-SAP) (LBG-BMcD, 2013c) – The SS-SAP provides a summary of various field sampling activities to be performed as well as QA/QC procedures for executing the RI/FS at the CFI Site. The SS-SAP establishes policies, organization, objectives, functional activities, and specific QA/QC activities for managing the CFI Site.

- ***Addendum No. 2 to the Installation-Wide Accident Prevention Plan and Site Safety and Health Plan for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*****,** (LBG-BMcD, 2013d) – Addendum No. 2 to the IW-APP/SSHP addresses the site-specific hazards and health and safety procedures to be followed during environmental investigations at the CFI Site. Addendum No. 2 to the IW-APP/SSHP also includes details for employee training, personal protective equipment usage, health surveillance, air monitoring, site security and control, decontamination, SOPs, and contingency planning at the CFI Site.

The SS-SAP is included as an attachment to this RI/FS WP in Appendix D. The SS-IDW, Addendum No. 2 to the IW-APP/SSHP, and QCP have been submitted under separate covers. The SS-SAP, SS-IDW, Addendum No. 2 to the IW-APP/SSHP, QCP will be used in conjunction with the Basic Documents at the CFI Site.

5.3 PRE- AND POST-FIELD INVESTIGATION ACTIVITIES

5.3.1 Pre-Field Investigation Activities

The purpose of the pre-field investigation activities for the RI/FS is to allow access to the CFI Site to help facilitate the field investigation activities. Pre-field investigation activities will include the following:

- Restore the low-water crossing over Threemile Creek and perform minor earthwork and dressing of the east and west approach of the low-water crossing;
- Install an access road for equipment at the west end of the bluff to gain access to the Kansas River floodplain; and
- Create pathways for the access of equipment for drilling and sample collection by clearing vegetation and brush present on the Kansas River floodplain.

The location of the low-water crossing and access road to the Kansas River floodplain are shown on Figure 5-1.

5.3.2 Post-Field Investigation Activities

The purpose of the post-field investigation activities for the RI/FS is to perform site restoration, erosion control, and re-seeding activities at the CFI Site once all field activities have been completed. Post-field investigation activities will include the following:

- Remove the low-water crossing over Threemile Creek and restore to pre-construction conditions;
- Remove access road at the west end of the bluff and restore to pre-construction conditions;
- Install erosion control measures such as straw bales and silt fencing to minimize soil erosion; and
- Re-seed all disturbed areas with Fort Riley-approved, grass seed mix.

5.4 FIELD INVESTIGATION ACTIVITIES

The purpose of the field investigation activities for the RI/FS is to provide sufficient data to determine the nature and extent of contamination, to assess potential risks to human health and the environment, to develop/screen remedial alternatives, and to, as needed, design remediation approaches. Section 6.0 of this RI/FS WP details the previous environmental investigations, presents the known data gaps, and summarizes the rationale and approach that will be used to fill those data gaps at the CFI Site. The

two-phased approach for conducting the field investigation activities will be used at the CFI Site during field activities (LBG-BMcD, 2013e).

5.4.1 Phase I Field Investigation Activities

The following field investigation activities will be conducted during Phase I of the RI:

- Collection of surface and subsurface background soil samples;
- Collection of surface soil samples from the overland flow drainage area;
- Collection of stream sediment samples from Threemile Creek;
- Collection of direct-push surface and subsurface soil samples at select locations;
- Collection of surface water samples from Threemile Creek; and
- Collection of direct-push groundwater samples at select locations.

5.4.2 Phase II Field Investigation Activities

The following field investigation activities will be conducted during Phase II of the RI:

- Collection of additional surface soil samples from the overland flow drainage area;
- Collection of additional stream sediment samples from Threemile Creek;
- Collection of additional direct-push surface and subsurface soil samples at select locations;
- Collection of additional surface water samples from Threemile Creek;
- Collection of additional direct-push groundwater samples at select locations;
- Installation, development, and slug testing of alluvial monitoring wells;
- Collection of groundwater level data; and
- Quarterly groundwater sampling using low-flow sampling techniques from the alluvial monitoring wells.
  - 1st Quarter Groundwater Sampling Event (Baseline Groundwater Sampling Event)
  - 2nd Quarter Groundwater Sampling Event

- 3rd Quarter Groundwater Sampling Event
- 4th Quarter Groundwater Sampling Event

5.4.3 Additional Field Investigation Activities

If, after completion of the Phase II field investigation, it is determined that additional field investigation activities are needed to fully define the nature and extent of contamination, then the following additional field work may be proposed:

- Collection of soil, stream sediment, surface water, and or groundwater samples;
- Installation of monitoring wells;
- Monitoring well sampling; and
- Slug testing.

5.5 SAMPLE CHEMICAL ANALYSIS AND VALIDATION

Soil, groundwater, surface water, and stream sediment samples that will be collected for off-site analysis as part of the RI Phase I and Phase II field efforts are detailed in Sections 6.0 of this RI/FS WP. TestAmerica, Inc. – West Sacramento (TestAmerica) of West Sacramento, California is the primary analytical laboratory for the analysis of soil, stream sediment, surface water, and groundwater samples for BTEX, TPH-DRO, TPH-GRO, TAL metals (23 elements), SVOCs (phenols and PAHs), dioxins/furans, and water quality parameters. Brooks Rand Labs, LLC. (BRL) of Seattle, Washington is the primary analytical laboratory for soil, stream sediment, surface water, and groundwater samples for MeHg. Both TestAmerica and BRL are accredited under the ELAP and certified by the state of Kansas. Samples will be analyzed according to the methods indicated in the SAP-IW and SS-SAP, specifically Tables 5-1 and 5-2 within the SAP-IW and SS-SAP. Sample preparations, shipment, and QC procedures are also outlined in the SAP-IW and SS-SAP.

Data will be validated by examining the accompanying data packages containing quantitation reports, and blank, standard, and spike results. A Level III data validation will be performed on all analytical data. Based on the results of these QC measures, the field sampling data in the BLRA will be judged reliable. Data evaluation/validation procedures are outlined in detail in the SAP-IW. The results of the data evaluation/validation will be included in the Quality Control Summary Report (QCSR) for the RI.

5.6 DATA EVALUATION

5.6.1 Phase I Data Evaluation

The physical and chemical data generated during Phase I of the RI/FS field investigation activities will be evaluated, interpreted, and summarized prior to the start of Phase II field activities. The Phase I data evaluation will be used to determine if and/or which analytes will be eliminated from the Phase II analytical suite. The Phase I data evaluation will include the following:

- Summarizing data in the following categories;
  - Surface and subsurface soil chemical analytical results
  - Stream sediment chemical analytical results
  - Surface water chemical analytical results
  - Groundwater chemical analytical results

- Compiling, analyzing, and validating the data collected (QCSR) as mentioned in Section 5.5 and detailed in the SAP-IW; and

- Screening the data against all appropriate screening levels as detailed in Section 4.2.5 and evaluating if and/or which analytes will be eliminated from the Phase II analytical suite.

The QCSR will be prepared for the Phase I data before any decisions will be made using the data.

5.6.2 Phase II Data Evaluation

The physical and chemical data generated during Phase II of the RI/FS field investigation activities will be evaluated, interpreted, and summarized. Phase II data evaluation will also incorporate the data collected during Phase I and will include the following:

- Summarizing data in the following categories;
  - Surface and subsurface soil chemical analytical results
  - Stream sediment chemical analytical results
  - Surface water chemical analytical results
  - Groundwater chemical analytical results

- Compiling, analyzing, and validating the data collected (QCSR) as mentioned in Section 5.5 and detailed in the SAP-IW for the RI Report and the BLRA Report;

- Compiling and analyzing data for the FS Report; and

- Evaluating if all data needs have been met.

Specifically, the following types of data, gathered during the RI/FS field investigation, will be evaluated:

- Surface and Subsurface Soil Data
  Results of chemical analyses of surface and subsurface soil samples will be used to determine presence or absence, and, if present, estimate nature and extent of soil contamination and provide information concerning contaminant levels and potential exposure pathways.

- Stream Sediment Data
  Results of chemical analyses of the sediment samples will be used to determine presence or absence, and, if present, estimate the nature and extent of contamination in the sediment and to provide information concerning contaminant levels and potential exposure pathways.

- Surface Water
  Results of chemical analyses of the surface water samples will be used to determine presence or absence, and, if present, estimate the nature and extent of contamination in the surface water and to provide information concerning contaminant levels and potential exposure pathways.

- Groundwater Data
  Results of chemical analyses of groundwater samples will be used to determine groundwater quality, estimate the nature and extent of contamination in the groundwater, and provide information concerning contaminant levels and potential exposure pathways.

- Geologic Data
  Geologic logs obtained during subsurface investigations (direct-push, hand augering, and/or drilling) will be evaluated to provide additional information on the extent of the ash/cinder layer and other subsurface conditions existing at the CFI Site. Field soil classifications will be used to evaluate soil properties as they relate to the evaluation of remedial alternatives. A Kansas State Licensed Geologist will review all geologic logs.

- Hydrogeologic Data
  Hydrogeologic data including water elevation measurements and in-situ hydraulic conductivity testing (slug tests) will be used to characterize the hydrogeology of the CFI Site.

5.7 MODELING

Fate and transport models predict the movement of chemicals through soil, groundwater, and/or air over time. The use of models may be necessary for predicting chemical concentrations at receptor points away from the source as a result of chemical migration or media transfer. The models vary in complexity, depending on assumptions made during model development, ranging from simple conservative algorithms to complex computer code. Models, if needed for this project, will be selected by considering a tiered approach where activities are approximately tailored to site-specific conditions and risks. The tiered approach considers increasingly sophisticated levels of data analysis from simple to complex, as appropriate to the CFI Site.

Fate and transport modeling will be performed during the RI process if quantitative estimates of future concentrations are deemed necessary and/or if the conceptual model cannot be confirmed with existing data. Fate and transport models will be evaluated based on their applicability to the CFI Site conditions, data requirements, regulatory acceptance, type of predictive information needed, and ability to simulate the CFI Site conditions.

If fate and transport modeling is deemed necessary, COPCs will be modeled using site-specific input parameters, where available. Otherwise, literature will be searched to ascertain the most applicable values for the CFI Site. A sensitivity analysis will also be performed to quantify the uncertainty of critical input parameters used in the models. Output from the fate and transport modeling will consist of numerical estimates for future concentrations of COPCs in soil and groundwater at potential receptor locations.

5.8 IDW

All IDW generated during the RI/FS will be characterized and disposed in accordance with local, state, and federal regulations as outlined in the IW-IDW and SS-IDW.

5.9 QCSRs

Six (6) QCSRs will be prepared for this project during the RI. A QCSR will be prepared following the completion of Phase I and Phase II field investigation activities and after each of the four (4) quarterly groundwater sampling event. All data will undergo an extensive data evaluation/validation and QA/QC review in accordance with the SAP-IW and SS-SAP.

5.10 PAR

The purpose of the PAR is to serve as a preliminary planning document for the BLRA. The PAR will be submitted to the USACE, Fort Riley PWE, and the Regulators (USEPA and KDHE), as a stand-alone submittal, prior to the RI and BLRA Reports. All comments generated from the PAR will be incorporated and addressed in the RI and BLRA Reports.

The PAR will include the following information:

PAR OUTLINE

1.0 Introduction
- 1.1 Objectives of the PAR
- 1.2 Contents of the PAR

2.0 Site Background and Description
- 2.1 Site Location and Description
- 2.2 Site Use
  - 2.2.1 Historic and Current
  - 2.2.2 Future Land Use and Plans
- 2.3 Physical Setting
  - 2.3.1 Features
  - 2.3.2 Site-Specific Soils
  - 2.3.3 Site-Specific Geology
  - 2.3.4 Hydrogeology
  - 2.3.5 Surface Water Hydrology
- 2.4 Water Use
- 2.5 Climatology
- 2.6 Demography
- 2.7 Ecology

3.0 Investigation History
- 3.1 Previous Investigations
- 3.2 Current Investigation
  - 3.2.1 Phase I Investigation
  - 3.2.2 Phase II Investigation

4.0 CSM
- 4.1 COPCs Selection Rationale
  - 4.1.1 Surface Soil
  - 4.1.2 Subsurface Soil
  - 4.1.3 Stream Sediment
  - 4.1.4 Surface Water
  - 4.1.5 Groundwater
- 4.2 Release and Transport Mechanisms

4.3 Affected Media
4.4 Potential Exposure Routes
4.4.1 Air Exposure Routes
4.4.2 Soil and Stream Sediment Exposure Routes
4.4.3 Surface Water Exposure Routes
4.4.4 Groundwater Exposure Routes
4.5 Potential Receptors
4.6 Estimation of Intake
4.6.1 Exposure Variables
4.6.2 Chemical Variables
5.0 Reference

5.11 BLRA

5.11.1 Introduction

The purpose of the BLRA is to evaluate potential human health and environmental effects associated with current and future exposures to the preliminarily identified COPCs in the absence of remediation. The BLRA will be conducted according to USEPA and KDHE (KDHE, 2010) methodologies. The human health evaluation will follow procedures outlined in the *Risk Assessment Handbook, Volume I: Human Health Evaluation* (USACE, 1995); *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Parts A, B, C, D, E, and F)* (USEPA, 1989, 1991, 2004, and 2009a); and other USEPA supplemental guidance. It should be noted that the previous listings are examples of guidance documents anticipated to be used, and is not a comprehensive list.

The environmental evaluation will be conducted following the procedures outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment* (USEPA, 1997a); and *Guidelines for Ecological Risk Assessments* (USEPA, 1998). The sections below outline the main steps to be followed in the human health and Tier 1 screening level ecological evaluation during the RI.

5.11.2 Human Health Evaluation Process

The human health evaluation quantifies potential risk and then compares the results to USEPA accepted levels of risk to determine significance. The process involves four steps: selection of COPCs, toxicity assessment, exposure assessment, and risk characterization.

5.11.2.1 Selection of COPCs

Selection of COPCs will be identified using procedures that conform to USEPA guidance. The guidance stipulates a nine-step process to organize the data into a form appropriate for assessing risk (USEPA,

1989). Typically, some type of screening is employed to limit the number of chemicals carried through the risk assessment while still assuring that cumulative risk is addressed. Selection may be based on comparison to background, frequency of detection, and/or a toxicity/concentration screen. Mobility and persistence of chemicals detected may also be considered in the selection of COPCs. At a minimum, screening for the CFI Site will include a comparison to site-specific background levels for the TAL metals (23 elements) and SVOCs (phenols and PAHs) from surface and subsurface soil. For background chemical data sets that have a normal distribution, a 95 percent UCL will be calculated using the most current version of the USEPA's ProUCL software. Maximum concentrations detected at the CFI Site will be compared to these values. For data sets that are not normally distributed, the maximum detected concentration will be used as the chemical background level. Sample concentrations that are unduly elevated may be tested as outliers, using the Dixon and Rosner Tests that are incorporated into the USEPA's ProUCL software before determining distribution type. Other screening techniques will be applied, as appropriate, based on the number and types of chemicals detected such as USEPA RSLs, and/or KDHE RSKs.

5.11.2.2 Toxicity Assessment

Toxicity information will be compiled for both carcinogenic and non-carcinogenic adverse health effects for all COPCs. The selection of toxicological information is provided below, and will follow the 2003 OSWER Toxicity Value Hierarchy (http://www.epa.gov/oswer/riskassessment/pdf/hhmemo.pdf).

- Tier 1 – USEPA's Integrated Risk Information System (IRIS)
- Tier 2 – USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) – The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center (STSC) develops PPRTVs on a chemical specific basis when requested by USEPA's Superfund program.
- Tier 3 – Other Toxicity Values – Tier 3 includes additional USEPA and non-USEPA sources of toxicity information. Priority should be given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed.

Chemicals for which there are no toxicity values available for quantifying risk will be qualitatively assessed.

5.11.2.3 Exposure Assessment

The exposure assessment identifies the pathways through which human populations are potentially exposed and estimates the magnitude, frequency, and duration of exposure to site-related COPCs. Main components of an exposure assessment include identification of potentially exposed populations, completed exposure pathways, and estimation of intake.

First the exposure setting will be characterized to identify potentially exposed populations since site conditions and land and water uses influence human activities and patterns of behavior. Completed exposure pathways will then be identified for each receptor population resulting in exposure scenarios to be evaluated. A completed exposure pathway contains the following four essential components:

- Chemical release
- Transport to an exposure point
- Presence of a receptor at an exposure point
- An exposure route

Once likely populations and pathways are identified, dose or intake will be calculated for COPCs in each pathway. Dose is determined by combining exposure variable values from guidance documents and will be used and referenced, if available. If not, best professional judgment about expected site conditions will be employed in estimating values for the exposure scenarios. A dose or intake is no longer calculated or used for inhalation exposures (USEPA, 2009a). The recommended values and estimated values will be specifically chosen to result in a reasonable maximum exposure (RME) estimate. A RME represents a high-end exposure situation, but a scenario within the realm of possible exposure.

Current USEPA risk assessment guidance specifies that the RME for a receptor population be calculated using the 95 percent UCL of the arithmetic mean of chemical concentrations. However, there are instances where the 95 percent UCL can be greater than the maximum detected value, such as when there are elevated detection limits or small sample sizes. In these situations, guidance recommends using the maximum detected concentration (USEPA, 1992a). For exposure points for which data is not currently available, the use of the models may be necessary. Models as discussed in Section 5.7 may be used for predicting current or future chemical concentrations at receptor points away from the source as a result of chemical migration or media transfer.

5.11.2.4 Risk Characterization

The final step in the human health evaluation characterizes non-carcinogenic hazards and carcinogenic risks for each scenario being assessed. To quantify the potential risk posed by exposure to chemicals through the identified exposure pathways, the intake of each chemical is combined with the appropriate toxicity values. The result represents the likelihood of risk from exposure to that chemical. The results are then compared to the USEPA standards for acceptable levels of risk, which is a hazard index (HI) of 1 and cancer risk between 10^{-4} to 10^{-6}. For total HIs greater than 1, segregation of HI values based on target organ(s) may be applied.

The risk characterization will also provide discussion of the uncertainties inherent in the process. This will include an evaluation or uncertainty in data collection and evaluation, chemical identification, toxicity assessment, and exposure assessment.

5.11.3 Environmental Evaluation Process

The environmental component of this BLRA will be a screening level evaluation of whether ecological receptors may potentially experience adverse effects from exposure to site-related chemical. Ecological risk does not exist unless:

- The chemical or stressor has the inherent ability to cause one or more adverse effects.
- It occurs with or contacts an ecological receptor long enough and at a sufficient intensity to elicit the identified adverse effect (USEPA, 1992a).

Ecologic risk will be assessed at the CFI Site in a Tier 1 screening level environmental evaluation. The components of a Tier 1 evaluation, described in the following sections, include environmental conditions characterization, identification of potential ecological receptors and exposure pathways, benchmark screening, and risk characterization.

5.11.3.1 Environmental Conditions Characterization

The first step in an environmental evaluation is to characterize the environmental conditions. A field study will be conducted to supplement the preliminary information obtained in developing the conceptual model and will include an inventory of commonly observed species, a description of the ecology and habitat types, and "qualitative examination for evidence of stress" or notation of any abnormal conditions observed among ecological receptors. Applicable agencies including the Fort Riley PWE, Conservation Branch will be contacted by letter requesting information on potentially sensitive species and habitats. In

addition, the nature and extent of contamination as well as fate and transport of chemicals in the environment will be considered as part of the environmental conditions discussion.

5.11.3.2 Identification of Potential Ecological Receptors and Exposure Pathways

Once environmental conditions are characterized, key ecological receptors and potential exposure pathways will be identified. Receptors are the components of ecosystems that are or may be adversely affected by a chemical or stressor. Since it is difficult to assess potential impacts to all receptors, assessment methods allow for selection of particular types of receptors (i.e. key receptors). For this screening evaluation, key receptors will be selected first from the list of species known or expected to be present at the CFI Site, as compiled during the field reconnaissance. Receptors will also be identified and grouped based upon their likelihood of exposure to specific media. A final criterion in the selection of key receptors will be availability of benchmarks in the literature, since toxicological information is generally limited.

The next step in the exposure assessment is estimation of exposure concentrations for the representative species. Numerous factors will influence the amount of exposure an individual receives during its life. Exposure modifying factors, along with normalizing factors (*e.g.,* body weight, growth rate), will be considered in developing exposure concentrations with units compatible to compiled benchmarks.

5.11.3.3 Benchmark Screening

Chemical concentrations will be screened against the ecological screening levels using the following hierarchy:

- USEPA Hazard Quotient (HQ) ecological soil screening levels (USEPA, 2010);
- USEPA Region 5 ecological screening levels (USEPA, 2003); and
- Oak Ridge National Laboratory (ORNL) ecological screening benchmark values (ORNL, 1998).

The ecological screening process will be used to refine the list of chemicals for risk characterization. Chemicals detected at concentrations less than background levels will not be evaluated further in the assessment. For this evaluation, ecological benchmarks will be obtained from sources recommended by the USACE guidance. A benchmark value is a known concentration of a substance that elicits a known effect to the ecological receptor. Benchmark values for soil microbes and plants are expressed in units of milligram of chemical per kilogram of soil. For wildlife, benchmark values for chemicals in soil or water are expressed as dose (i.e., milligrams of chemical per kilogram body weight per day). Wildlife

benchmark values are found in the literature as either no observable adverse effects level (NOAEL) or lowest observable adverse effects levels (LOAEL).

The NOAEL will be used as the initial benchmark for assessing potential risk to wildlife receptors from chemical exposure. A NOAEL is defined as the highest level of a stressor evaluated in an experimental test at which no adverse effects are observed. If a NOAEL is exceeded, the chemical concentration will then be compared to the LOAEL, a secondary benchmark. The LOAEL is the lowest level at which effects are observed in a study. Only those chemicals exceeding the NOAEL and the LOAEL will be identified as Chemicals of Potential Ecological Concern (COPECs).

5.11.3.4 Risk Characterization

The risk characterization process compares the exposure and toxicity profiles, incorporates any uncertainties, and quantitatively discusses the weight of evidence (USEPA, 1997a). Based on the fate and transport presentation, the likelihood of future potential risks will also be discussed. This section of the evaluation will also discuss the uncertainties inherent in the process.

USEPA acknowledges that, although a benchmark screening approach is appropriate for some risk assessments; many risk assessments are not based on benchmark decisions. Rather, ecological risk management decisions may depend on a more qualitative assessment of ecosystem integrity, including sustainability, resiliency, and biodiversity as observed during a field study (USEPA, 1997a). Therefore, this environmental evaluation will utilize a qualitative (observable) as well as a quantitative (screening) process to characterize the potential risk.

5.12 RI AND BLRA REPORTS

Following completion of the RI, a RI Report and BLRA Report for the CFI Site will be prepared presenting all pertinent data on investigation results. As indicated below, the reports will generally conform to the guidance provided by USEPA, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988).

The RI Report will include the following information:

RI REPORT OUTLINE

Executive Summary
1.0 Introduction
  1.1 Purpose of Report
  1.2 Site Background
    1.2.1 Site Description

1.2.2 Site History
1.2.3 Previous Investigations
1.3 Report Organization
2.0 Physical Setting
2.1 Surface Features
2.1.1 Regional Surface Features
2.1.2 Site-Specific Surface Features
2.2 Climatology
2.3 Geology and Soils
2.3.1 Regional Geology and Soils
2.3.2 Site-Specific Geology and Soils
2.4 Surface Water Hydrology
2.4.1 Regional Surface Water Drainage
2.4.2 Site-Specific Surface Water Drainage
2.5 Surface Water Hydrology
2.5.1 Regional Hydrology
2.5.2 Site-Specific Hydrology
2.6 Demography
2.7 Land Use
2.7.1 Current Land Use
2.7.2 Future Land Use
2.8 Groundwater Use
2.8.1 Current Groundwater Use
2.8.2 Future Groundwater Use
3.0 RI Field Activities
3.1 Phase I Field Investigation
3.1.1 Background Soil Investigation
3.1.2 Surface Soil and Stream Investigation
3.1.3 Surface Water Investigation
3.1.4 Direct-Push Soil Investigation
3.1.5 Direct-Push Groundwater Investigation
3.2 Phase II Field Investigation
3.2.1 Surface Soil and Stream Investigation
3.2.2 Surface Water Investigation
3.2.3 Direct-Push Soil Investigation
3.2.4 Direct-Push Groundwater Investigation
3.2.5 Monitoring Well Installation
3.2.6 Monitoring Well Sampling
3.2.7 Aquifer Characterization
3.3 IDW Management
4.0 Nature and Extent of Contamination

4.1 Sources
4.2 Background Values for Metals
4.3 Overview of Contamination in the Environment
4.4 Surface and Subsurface Soil Contamination
4.5 Stream Sediment Contamination
4.6 Surface Water Contamination
4.7 Groundwater Contamination
4.8 Summary
5.0 Contaminant Fate and Transport Evaluation
5.1 Introduction
5.2 Fate and Transport Mechanisms
5.3 Evaluation of Fate and Transport Mechanisms
5.3.1 Non-Destructive Mechanisms
5.3.2 Destructive Mechanisms
5.4 Contaminant Persistence
5.4.1 Physical Characteristics
5.4.2 Biodegradation Rates
5.5 Contaminant Migration
5.6 Modeling (If Necessary)
5.6.1 Models
5.6.2 Assumptions/Input Parameters
5.6.3 Model Calibration
5.6.4 Modeling Results
6.0 Summary and Conclusions
6.1 Summary
6.1.1 Nature and Extent of Contamination
6.1.2 Fate and Transport
6.1.3 Data Limitations
6.2 Conclusions and Recommendations for Future Work
7.0 References

The BLRA Report will include the following information:

BLRA REPORT OUTLINE

Executive Summary
1.0 Human Health Baseline Risk Assessment
1.1 Introduction
1.1.1 Purpose of Report
1.1.2 Methodology
1.1.3 Organization
1.2 Identification of Chemicals of Potential Concern

1.2.1 Historical Data Evaluation
1.2.2 RI Data Evaluation
1.2.3 Media of Potential Concern
1.2.4 Identification of COPCs
1.3 Toxicity Assessment
1.3.1 Noncancer Effects
1.3.2 Cancer Effects
1.3.3 Chemicals without Toxicity Values
1.4 Exposure Assessment
1.4.1 Characterization of Exposure Setting
1.4.2 Potentially Exposed Populations
1.4.3 Potential Exposure Pathways
1.4.4 Estimation of Intake
1.5 Risk Characterization
1.5.1 General Noncancer Risk Discussion
1.5.2 General Cancer Risk Discussion
1.5.3 Risk Estimates
1.6 Uncertainties
1.6.1 Uncertainties Associated with Chemical Identification
1.6.2 Uncertainties from Toxicity Assessment
1.6.3 Uncertainties from Exposure Assessment
1.7 Human Health Baseline Risk Assessment Summary
2.0 Ecological Evaluation
2.1 Introduction
2.2 Ecological Site Characterization
2.2.1 Ecosystems and Species of Concern
2.2.2 Potential Ecological Receptors and Exposure Pathways
2.3 Ecological Evaluation Process
2.3.1 Chemicals of Potential Ecological Concern
2.3.2 Benthic Organisms Benchmark Screening Methodology
2.3.3 Vegetation Screening Methodology
2.3.4 Exceptions to Screening Methodology
2.4 Risk Characterization
2.5 Predicted Future Conditions and Potential Risk
2.6 Uncertainties
2.7 Ecological Evaluation Summary
3.0 Conclusions
3.1 Conceptual Site Model
3.1.1 Human Health CSM
3.1.2 Ecological CSM
3.2 Risk Assessment

3.2.1 Summary of Human Health Risk
3.2.2 Summary of Ecological Risk
3.3 Conclusions
4.0 References

5.13 DEVELOPMENT AND SCREENING ALTERNATIVES

5.13.1 Introduction

A FS will be conducted upon completion of the RI. The first overall step in the FS process is the development of remedial alternatives. This step is comprised of the following components:

- Development of RAOs
- Development of GRAs
- Identification of remedial areas or volumes
- Identification and screening of remedial technologies and process options
- Evaluation of remedial process options
- Development of remedial alternatives

These components of the FS are described in the following paragraphs.

5.13.1.1 Development of RAOs

Preliminary RAOs identified in Section 3.5 will be reviewed and updated based on the RI data. The refined RAOs will provide the basis for development of remedial alternatives.

5.13.1.2 Development of GRAs

GRAs are broad categories of remedial options that are identified to satisfactorily address the RAOs. GRAs identified in Section 3.6 will be refined as appropriate based on the RI data.

5.13.1.3 Identification of Areas or Volumes of Contaminated Media

RI analytical results will be compared with RAOs to define areas or volumes of media to be evaluated in the FS. Remedial alternatives will be developed to address those areas or volumes where contaminant levels exceed PRGs.

5.13.1.4 Identification and Screening of Technologies and Process Options

Technologies and process options identified in Section 3.6 will be re-evaluated based on RI data and further technological developments. A refined list of technologies will be screened based on available information to eliminate technologies that are not technically implementable at the CFI Site.

5.13.1.5 Evaluation of Process Options

Following initial technology screening, the remaining potentially applicable technologies and process options will be further evaluated to determine which are potentially feasible for implementation at the CFI Site. This evaluation considers the relative effectiveness, implementability, and cost of each process for achieving remedial goals. This evaluation further eliminates the process options under consideration to simplify subsequent development and evaluation of alternatives.

5.13.1.6 Development of Alternatives

Remedial alternatives will be developed to meet established RAOs for the site remedy. Alternatives will include a combination of retained technologies and process options to address site contamination.

In developing alternatives, consideration will be given to the following, as indicated by the NCP [40 CFR Part 300.430(e)]:

- Inclusion of a no-action alternative.
- Development of a focused range of alternatives that achieve site-specific remediation levels within different time periods using one or more different technologies.
- Consideration of innovative treatment technologies.
- Inclusion of alternatives that provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances, pollutants, or contaminants. Controls include both engineering and institutional controls.
- Inclusion of alternatives that provide, as their principal element, the reduction of toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants by treatment.

Descriptions of each remedial alternative will include the rationale and strategy for selection of technology components in each alternative and the role of each within the remedial alternative. For cost analysis, assumptions will be made regarding preliminary locations and capacities of selected remedial

processes. Actual locations and capacities will be determined during the remedial design phase should the alternative be selected as the final remedy.

5.13.2 Screening of Alternatives

Following alternative development, an initial screening of alternatives will be performed, depending upon the complexity of the site. USEPA (USEPA, 1988) has indicated that a screening step is often unnecessary for groundwater. Only the alternatives judged as the best or most promising on the basis of these evaluation factors should be retained for further consideration and analysis. If, after completion of the RI, it appears that screening is appropriate for this site, the following criteria will be used to narrow the range of remedial alternatives:

- Effectiveness
- Implementability
- Cost

5.14 ANALYSIS OF ALTERNATIVES

The detailed analysis of remedial alternatives consists of two parts: an analysis of each alternative and a comparative analysis of all alternatives. According to the NCP [40 CFR 300.430 (e)(9)(iii)], remedial alternatives are evaluated according to the following nine criteria:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State (or support agency) acceptance

- Community acceptance

The first two criteria (protection of human health and the environment and compliance with ARARs) are considered threshold criteria; they must be met (unless a specific ARAR is waived) for the alternative to be eligible for selection. The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost) are considered balancing criteria. These criteria are the primary criteria upon which the detailed analysis will be based. The final two criteria (state or support agency acceptance and community acceptance) are modifying criteria that are evaluated during preparation of the Record of Decision (ROD), following comments on the RI/FS and Proposed Plan (PP). Consequently, these last two criteria will not be completed during the FS.

Individual analyses will include an assessment of each alternative against each of the seven threshold and balancing criteria. Once alternatives have been described and individually assessed, a comparative analysis is conducted to consider advantages and disadvantages of alternatives so that the remedy that offers the most favorable balance among the criteria can be selected.

5.15 FS REPORT

Following completion of the FS, a comprehensive FS Report for the CFI Site will be prepared to document the development and analysis of remedial alternatives. As indicated below, the format of the FS Report will generally conform to the USEPA guidance (USEPA, 1988).

The FS Report will include the following information:

FS REPORT OUTLINE

Executive Summary
1.0 Introduction
- 1.1 Purpose and Organization of Report
- 1.2 Background Information
  - 1.2.1 Site Description
  - 1.2.2 Site History
  - 1.2.3 Nature and Extent of Contamination
  - 1.2.4 Contaminant Fate and Transport
  - 1.2.5 Baseline Risk Assessment

2.0 Identification and Screening of Technologies
- 2.1 Applicable or Relevant and Appropriate Requirements
- 2.2 Remedial Action Objectives
- 2.3 General Response Actions

2.4 Identification and Screening of Technology Types and Process Options
2.4.1 Identification and Screening of Technologies
2.4.2 Evaluation of Technologies and Selection of Representative Technologies
3.0 Development and Screening of Remedial Alternatives
3.1 Development of Alternatives
3.2 Description of Remedial Alternatives
3.3 Screening of Alternatives (as necessary)
4.0 Detailed Analysis of Alternatives
4.1 Introduction
4.2 Individual Analysis of Alternatives
4.3 Comparative Analysis
5.0 References

The FS Report will provide the basis for remedy selection by the lead agency.

5.16 TREATABILITY STUDY

Technologies that may be suitable for the CFI Site will be identified as early as possible to determine whether there is a need to conduct treatability studies to better estimate costs and performance capabilities. A bench test or a pilot study may be conducted if the USACE-CENWK deems it necessary. BMcD will submit a Treatability Study Work Plan (TSWP) identifying the types and goals of the study. The purpose of the treatability study will be to determine the suitability of remedial technologies to CFI Site conditions and problems.

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6.0 DATA EVALUATION AND SAMPLE RATIONALE

6.1 INTRODUCTION

This section of the RI/FS WP presents the evaluation of the existing CFI Site data and the rationale for additional sampling needed to complete the RI/FS. The evaluation of the data and sampling rationale is presented below. The location of the CFI Site is shown on Figures 2-2 and 2-3.

Field investigation activities described in subsequent sections may be modified as field activities progress and analytical results become available. This could result in the addition or deletion of sampling locations or lines. Any deviations from this RI/FS WP will be discussed with and approved by the USACE-CENWK Project Manager (PM) prior to implementation.

6.2 PREVIOUS SAMPLING RESULTS

A field investigation was conducted in early 2000 by Arrowhead (Arrowhead, 2001). This investigation was performed to determine whether shallow soils at and adjacent to the foundation of the CFI were impacted by heavy metals contamination. Shallow soil samples were screened in the field using XRF equipment. Confirmation samples were also sent to an off-site laboratory for analysis. Copies of all previous field investigation reports at the CFI Site are provided in Appendix A.

In December 2006, the USACE-CENWK performed additional soil sampling at the CFI Site (USACE-CENWK, 2007). The objectives of this investigation were to verify the results from the XRF investigation conducted in 2000 and to determine the distribution of metals arising from the previous use of the incinerator. One hundred (100) surface and shallow subsurface soil samples were collected in the area around the incinerator foundation, on the floodplain slope, and at the toe of the floodplain slope. Soil samples were submitted for analysis of RCRA metals (8 elements). Toxicity Characteristic Leaching Procedure (TCLP) was run on selected samples to determine whether the potential existed for the leaching of metals to groundwater. Appendix A contains a complete copy of the USACE-CENWK report. The results of this investigation included:

- The sampling demonstrated that the results of the 2000 XRF investigation were generally representative of the CFI Site;
- Concentrations of arsenic and lead in the soil (below RSKs, but above background) indicated that the effects of past incinerator use were limited to the west and south of the CFI Site; and

- TCLP results suggested that there was a low probability that contaminants would leach from the soil to the groundwater at the CFI Site.

A detailed discussion of the sampling results for the 2000 and 2006 soil data is not included herein, as virtually all of this soil was removed from the upland surface during the 2010 field activities performed by CTI at the CFI Site. These activities and the analytical results are discussed below.

In 2010, CTI performed additional soil sampling at the CFI Site. CTI also performed demolition, removal, and off-site disposal of the incinerator foundation and contaminated upland surface soil as special waste (CTI, 2010). Appendix A contains a complete copy of the CTI report.

The activities performed by CTI included:

- Site preparation activities, including the installation of a low-water crossing on Threemile Creek, and the clearing, grubbing, and disposal of vegetation;
- Removal of clean soils from the rail spur to improve access to the investigation area;
- Excavation of eight (8) test trenches to delineate extent of ash. Collection of ash samples for off-site analysis. Trenches were then backfilled;
- Demolition, removal, and off-site disposal of the incinerator foundation and contaminated upland surface soils as special waste; and
- Confirmation soil sampling of the upland area and incinerator foundation to confirm soil removal meets KDHE RSK criteria for residential land use.

The CTI report discusses details of these activities. The following section describes in greater detail the nature and extent of the ash, and the analytical results for samples collected.

CTI described the ash along the floodplain slope at the CFI Site as ranging from nonexistent at the eastern and western most test pits to 8 ft in thickness. The ash deposits located on the floodplain slope are typically covered by a layer of soil and organic matter ranging in thickness from several inches to over 1 ft. Toward the toe of the floodplain slope and on the Kansas River floodplain, the ash deposits are covered by either floodplain sediment and/or dust bowl silt deposits. The ash deposits within the Kansas River floodplain are typically less than a 1 ft in thickness, are finer grained with less granular cinders than

the ash on the floodplain slope, and become visibly indistinguishable from the fine-grained silt and clay deposits (CTI, 2010).

Between September 27 and October 6, 2010, eight (8) test trenches (TP-0 through TP-7) were excavated in an attempt to delineate the vertical and horizontal extent of the CFI ash into the floodplain slope. Following the excavation of the test trenches, ash/soil analytical samples were collected from the test trenches were ash deposits were observed (TP-1 through TP-6). Five (5) grab and six (6) composite samples of ash were collected and analyzed for RCRA metals (8 elements) and TCLP RCRA metals (8 elements). Ten (10) soil grab samples were also collected and analyzed for RCRA metals (8 elements).

All eight metals were detected in the ash grab samples. Only arsenic detections exceeded the 2010 KDHE RSK for residential soil of 11.3 milligrams per kilogram (mg/Kg) in TP-4, TP-5, and TP-6 samples. The ash grab samples analyzed for TCLP RCRA metals (8 elements) had detections of barium, cadmium, chromium, lead, and silver with no detections exceeding the 2010 KDHE RSKs for residential soil.

The ash composite samples analyzed for RCRA metals (8 elements) had detections of all eight metals. Only arsenic detections exceeded the 2010 KDHE RSKs residential soil of 11.3 mg/Kg in TP-1 through TP-6 samples. The ash composite samples analyzed for TCLP RCRA metals (8 elements) had detections of arsenic, barium, cadmium, chromium, lead, and mercury with no detections exceeding the 2010 KDHE RSKs for residential soil.

The soil grab samples analyzed for RCRA metals (8 elements) had detections of arsenic, barium, cadmium, chromium, lead, and mercury. No metals detections in the soil grab samples exceeded the 2010 KDHE RSKs for residential soil.

All analytical data from previous environmental investigations for soil or ash that is still present at the CFI Site will be reviewed prior to use in the BLRA. All analytical data determined to be useful will be used in the BLRA.

6.3 RATIONALE AND APPROACH

6.3.1 Phase I Rationale and Approach

Activities to support Phase I of the RI/FS at the CFI Site include:

- Collection of background soil samples from an off-site location with an analogous soil type and depositional environment to evaluate natural and anthropogenic distribution and occurrences at

the CFI Site;

- Collection of surface soil samples from overland flow drainage areas to determine the presence or absence of contamination within the surface soil in overland flow drainage areas at the CFI Site;
- Collection of stream sediment samples from Threemile Creek to determine the presence or absence of contamination within the stream sediment of Threemile Creek at the CFI Site;
- Collection of surface water samples from Threemile Creek to determine the presence or absence of contamination within the stream sediment of Threemile Creek at the CFI Site;
- Collection of surface and subsurface soil to determine the presence or absence, and if present, define the horizontal and vertical extent of soil contamination at the CFI Site;
- Collection of direct-push groundwater to determine the presence or absence, and if present, define the horizontal and vertical extent of groundwater contamination at the CFI Site; and
- Data validation, evaluation, and screening to determine if and/or which analytes will be eliminated from the Phase II sampling activities at the CFI Site.

6.3.2 Phase II Rationale and Approach

Field activities to support Phase II of the RI/FS at the CFI Site include:

- Collection of additional surface soil samples from overland flow drainage areas near the trap/skeet range to determine if contaminants from the former trap/skeet range are potentially impacting the CFI Site;
- Collection of additional up-gradient stream sediment samples from Threemile Creek to determine if up-gradient contaminants from either the Custer Hill Wastewater Treatment Plant or the former trap/skeet range are potentially impacting the CFI Site;
- Collection of additional up-gradient surface water samples from Threemile Creek to determine if up-gradient contaminants from either the Custer Hill Wastewater Treatment Plant or the former trap/skeet range are potentially impacting the CFI Site;
- Collection of surface and subsurface soil to further define the horizontal and vertical extent of soil contamination at the CFI Site;

- Collection of direct-push groundwater to further define the horizontal and vertical extent of groundwater contamination, if present at the CFI Site;
- Installation and development of monitoring wells to allow continued monitoring of groundwater at the CFI Site;
- Quarterly collection of groundwater samples from newly installed monitoring wells to determine nature and seasonal variations in groundwater at the CFI Site; and
- Characterization of hydrogeologic properties of the aquifer via slug testing to evaluate fate and transport of contamination at the CFI Site.

Data to fill the gaps are needed to determine nature and extent of any contamination present, fate and transport of the contamination, and potential risk to human health and the environment; and to aid in possible remedial design. To fill the data gaps, the two-phased sampling approach outlined above and discussed in more detail in the following sections is planned. Sample procedures for the following field activities are detailed in the SAP-IW and the SS-SAP. Specific SAP sections are referenced for procedures as appropriate.

If, after completion of the Phase II field investigation, it is determined that additional field investigation activities are needed to fully define the nature and extent of contamination, then the following additional field work may be proposed:

- Collections of soil, stream sediment, surface water, and or groundwater samples;
- Installation of monitoring wells;
- Monitoring well sampling; and
- Slug testing.

6.3.3 Phase I Sampling Activities

6.3.3.1 Collection of Background Soil Samples

Twelve (12) hand auger borings (BG-01 through BG-12) will be advanced for background concentration determination from off-site locations with an analogous soil type with four (4) of the hand auger borings being from each depositional environment (upland terrace, floodplain slope, and Kansas River floodplain) (Figure 6-1). These hand auger borings will be continuously sampled for classification from ground

surface to 4 ft bgs using a stainless-steel hollow core-barrel hand-auger sampler. If refusal is met before reaching the target boring depth, the boring will be offset 3 ft and attempted one more time to verify. Hand-auger borings will be performed in accordance with the SOP #103 in the SAP-IW and SS-SAP. Two soil samples for chemical analysis will be collected from each boring at the depth intervals of 0 ft to 0.5 ft bgs and 3 ft to 4 ft bgs. The field geologist will prepare a lithologic log of each hand auger boring in accordance with the SOP #508 in the SAP-IW and SS-SAP. Background soil samples will be sent for off-site analysis of TAL metals (23 elements) and SVOCs (phenols and PAHs).

See Table 6-1 for specific sampling and labeling requirements for background soil sampling activities.

6.3.3.2 Collection of Surface Soil and Stream Sediment Samples

Five (5) surface soil samples (SS-01 through SS-05) will be collected from the overland flow drainage area that drains into Threemile Creek (Figure 6-2). These surface soil samples will be collected using hand tools (i.e. shovel, trowel, etc.) from ground surface to 0.5 ft bgs. If refusal is met before reaching the target boring depth, the boring will be offset 3 ft and attempted one more time to verify. The field geologist will briefly describe the lithology of each surface soil sample in the field logbook in accordance with SOP #508 in the SAP-IW and SS-SAP. Surface soil samples will be collected in accordance with the SOP #102 in the SAP-IW and SS-SAP. Surface soil samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans.

Three (3) stream sediment samples (SD-01 through SD-03) will be collected from Threemile Creek (Figure 6-2). One (1) stream sediment sample will be collected up-gradient of where the overland flow area drains into Threemile Creek, one (1) stream sediment sample will be collected adjacent to where the overland flow area drains into Threemile Creek, and one (1) stream sediment sample will be collected down gradient of where the overland flow area drains into Threemile Creek. These stream sediment samples will be collected from the bottom of Threemile Creek using a long-handled Teflon ladle. Stream sediment samples will be collected from the sediment material immediately below the water approximately mid-stream of Threemile Creek. The field geologist will briefly describe the lithology of each stream sediment sample in the field logbook in accordance with SOP #508 in the SAP-IW and SS-SAP. Stream sediment samples will be collected in accordance with the SOP #101 in the SAP-IW and SS-SAP. Stream sediment samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans.

See Table 6-2 for specific sampling and labeling requirements for Phase I stream sediment sampling activities.

6.3.3.3 Collection of Surface Water Samples

Three (3) surface water samples (SW-01 through SW-03) will be collected from Threemile Creek (Figure 6-2). These surface water samples will be collected at the same locations where stream sediment samples were collected as described above in Section 6.3.3.2. These surface water samples will be collected from the surface of the Threemile Creek using a long-handled Teflon ladle. Surface water samples will be collected in accordance with the SOP #208 in the SAP-IW and SS-SAP. The depth of each sample collected will be recorded in the field logbook along with pH, temperature, and specific conductivity. Surface water samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. Surface water samples collected for TAL metals (23 elements) will be filtered in the field prior preservation and shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

Surface water and stream sediment samples will be co-located. During sampling, samples will be first collected from the down gradient location moving up-gradient. Due to the surface water and stream sediment samples being co-located the surface water sample will be collected prior to the stream sediment sample.

See Table 6-3 for specific sampling and labeling requirements for Phase I surface water sampling activities.

6.3.3.4 Collection of Direct-Push Samples

6.3.3.4.1 Collection of Soil Samples

Seven (7) direct-push borings (DP-01 through DP-07) will be advanced along sampling transect lines down the floodplain slope and onto the Kansas River floodplain (Figure 6-3). Sampling transect lines will be laid out by field personnel using a measuring wheel, tape measure, and compass. Boring locations will be marked out using stakes. These direct-push borings will be continuously sampled for classification, using a 2-inch Macrocore® sampler, from ground surface to total depth. If refusal is met before reaching the target boring depth, the boring will be offset 3 ft and attempted one more time to verify. Soil sampling using direct-push technology will be performed in accordance with the SOP #103 in the SAP-IW and SS-SAP. In general, four (4) soil samples for chemical analysis will be collected from each direct-push boring. One (1) soil sample will be collected from each of the following targeted lithologic zones:

Surface Soil Zone

A surface soil sample will be collected from ground surface to 0.5 ft bgs. These samples are intended to characterize the surface soils at the CFI Site and to determine if, where, and to what extent contamination from aerial and/or erosional deposits from the operations of the CFI exists.

Ash Deposit Zone

A grab sample of the ash/cinder material will be collected from the middle of the ash deposit zone. Based upon the thickness of the ash deposit zone the field geologist may collect additional samples. The ash deposit zone sample will vary in depth and vertical thickness depending on boring location. In general the ash deposit zone is shallower and thicker toward the top of the floodplain slope becoming deeper and thinner toward the toe of the floodplain slope and on the Kansas River floodplain. These samples are intended to characterize the ash deposit zone and to determine the horizontal and vertical extent of contamination related to the ash deposits at the CFI Site.

Soil Below Ash Zone

A subsurface soil sample will be collected from immediately below the ash deposit zone. This sample will be collected from the first one (1) ft of subsurface soil immediately below the ash deposit zone. These samples are intended to characterize the soil below the ash deposit zone, to determine if contamination is leaching from the ash deposit zone, and, if so, what the horizontal and vertical extent of leaching-related contamination is.

Soil 6 Ft to 10 Ft Below Ash Zone

An additional subsurface soil sample will be collected from below the ash deposit zone. A sample will be collected from an interval of 6 ft to 10 ft below the ash deposit zone. The actual depth of sample collection will be based on photoionization detector (PID) readings and any visual indicators of possible contamination such as soil staining. These samples are intended to characterize the soil below the ash deposit zone, to determine if contamination is leaching from the ash deposit zone, and, if so, what the horizontal and vertical extent of leaching related contamination is.

If there are direct-push borings in which there is not a visually discernible ash deposit zone present, the BMcD PM and USACE-CENWK PM will be contacted to determine the number of samples and sampling intervals.

The field geologist will prepare a lithologic log of each direct-push boring per SOP #508 in the SAP-IW and SS-SAP and will screen the soil from ground surface to the bottom of borehole using a PID. The field geologist will use the PID screening results, visual staining (if present), and best judgment in

selecting where to collect soil samples within these zones. The field geologist will also have the discretion to collect additional samples if elevated PID screening results are encountered or staining is observed.

Some sample locations located on the floodplain slope may be inaccessible with a direct-push rig due to the steepness of the slope. At these locations soil samples will be collected from the lithologic zones using a stainless-steel, hollow core-barrel, hand-auger sampler. Soil samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans.

See Table 6-4 for specific sampling and labeling requirements for Phase I direct-push soil sampling activities.

Phase I soil sampling locations are biased towards sample collection within or very near the areas where incinerator ash has been mapped during previous investigations; however, two (2) direct-push borings (DP06 and DP-07) are located on the Kansas River floodplain. The field geologist will have the authority to adjust sampling locations, as appropriate, based on field screening, observations made during soil logging, and site conditions.

6.3.3.4.2 Collection of Groundwater Samples

Following the collection of the soil samples, five (5) selected direct-push borings (DP-08 through DP-12) will be advanced to the top of the water table. Groundwater samples will be collected at the proposed locations along the sampling transect lines from the floodplain slope, at the toe of the floodplain, and on the Kansas River floodplain (Figure 6-3). Sampling transect lines will be laid out by field personnel using a measuring wheel, tape measure, and compass. Boring locations will be marked out using stakes. At each boring location, a single groundwater samples will be collected form the first groundwater encountered. Groundwater sampling using direct-push technology will be performed in accordance with the SOP #209 in the SAP-IW and SS-SAP. Groundwater samples will be collected from each of these selected direct-push borings for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. Groundwater samples collected for TAL metals (23 elements) will be filtered in the field prior to preservation and shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

See Table 6-4 for specific sampling and labeling requirements for Phase I direct-push groundwater sampling activities.

Phase I groundwater sample locations are biased towards the south and east, as this is the presumed direction in which groundwater flows.

6.3.4 Phase I Data Evaluation

Following the completion of the Phase I field sampling activities, all analytical data collected will be compiled, analyzed, and validated in accordance with the procedures detailed in the SAP-IW and SS-SAP. After the analytical data has been compiled, analyzed, and validated, chemical detections will be compared to matrix-appropriate screening levels (see Section 4.2.5). The most conservative (residential) screening levels will be used in this data evaluation. Only chemicals detected at concentrations greater than their respective screening levels will continue as COPCs. The Phase I data evaluation results and recommendations will reviewed by both the USEPA and KDHE for regulatory approval prior to any changes in the Phase II analytical suite. Upon approval, any chemical that is eliminated as a COPC in the Phase I data evaluation process will be dropped from the analytical suite of all Phase II sampling activities.

In addition, the Phase I surface soil, stream sediment, and surface water samples will be evaluated to determine whether or not the analytical data is being affected by possible upstream contaminant sources (trap/skeet range and wastewater plant). If there are anomalous detections in any of the Phase I up-gradient samples collected, it may be an indication of contribution of contaminants from sources upstream of Threemile Creek and additional surface soil, stream sediment, and surface water samples will be collected during Phase II sampling activities.

6.3.5 Phase II Sampling Activities

6.3.5.1 Collection of Surface Soil and Stream Sediment Samples

Based upon the Phase I data evaluation, if it appears that contaminants from either the wastewater plant or the trap/skeet range are impacting surface soil and/or stream sediment within or adjacent to Threemile Creek, then additional samples of those matrices will be collected.

Three (3) surface soil samples (SS-06 through SS-08) will be collected from the overland flow drainage area that drains into Threemile Creek (Figure 6-4). These surface soil samples will be collected using hand tools (i.e. shovel, trowel, etc.) from ground surface to 0.5 ft bgs. If refusal is met before reaching the target boring depth, the boring will be offset 3 ft and attempted one more time to verify. The field geologist will briefly describe the lithology of each surface soil sample in the field logbook in accordance with SOP #508 in the SAP-IW and SS-SAP. Surface soil samples will be collected in accordance with the SOP #102 in the SAP-IW and SS-SAP. Surface soil samples will be sent for off-site analysis of

BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. However, it is possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation (see Section 6.3.4).

Three (3) stream sediment samples (SD-04 through SD-06) will be collected from Threemile Creek (Figure 6-4). One (1) stream sediment sample will be collected up-gradient of where the overland flow from the trap/skeet range drains into Threemile Creek, one (1) stream sediment sample will be collected adjacent to where the overland flow from the trap/skeet range drains into Threemile Creek, and one (1) stream sediment sample will be collected down gradient of where the overland flow from the trap/skeet range drains into Threemile Creek. These stream sediment samples will be collected from the bottom of Threemile Creek using a long-handled Teflon ladle. Stream sediment samples will be collected from the sediment material immediately below the water approximately mid-stream of Threemile Creek. The field geologist will briefly describe the lithology of each stream sediment sample in accordance with SOP #508 in the SAP-IW and SS-SAP. Stream sediment samples will be collected in accordance with the SOP #101 in the SAP-IW and SS-SAP. Stream sediment samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. However, it is possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation (see Section 6.3.4).

See Table 6-5 for specific sampling and labeling requirements for Phase II stream sediment sampling activities.

6.3.5.2 Collection of Surface Water Samples

Based upon the Phase I data evaluation, if it appears that contaminants from either the wastewater plant or the trap/skeet range are impacting surface water within or adjacent to Threemile Creek, then additional surface water samples will be collected.

Three (3) surface water samples (SW-04 through SW-06) will be collected from Threemile Creek (Figure 6-4). These surface water samples will be collected at the same locations described above in Section 6.3.5.1 where stream sediment samples were collected. These surface water samples will be collected from the surface of the Threemile Creek using a long-handled Teflon ladle collecting water. Surface water samples will be collected in accordance with the SOP #208 in the SAP-IW and SS-SAP. The depth that each sample is collected at will be recorded in the field logbook along with pH, temperature, and specific conductivity. Surface water samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. However, it is

possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation (see Section 6.3.4). Surface water samples collected for TAL metals (23 elements) will be filtered in the field prior to preservation and shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

Surface water and stream sediment samples will be co-located. During sampling, samples will be first collected from the down gradient location moving up-gradient. Due to the surface water and stream sediment samples being co-located the surface water sample will be collected prior to the stream sediment sample.

See Table 6-6 for specific sampling and labeling requirements for Phase II surface water sampling activities.

6.3.5.3 Collection of Direct-Push Samples

6.3.5.3.1 Collection of Soil Samples

Twelve (12) direct-push borings (DP-13 through DP-24) will be advanced along the sampling transect lines down the floodplain slope and onto the Kansas River floodplain (Figure 6-5). Sampling transect lines will be laid out by field personnel using a measuring wheel, tape measure, and compass. Boring locations will be marked out using stakes. These direct-push borings will be continuously sampled for classification, using a 2-inch Macrocore® sampler, from ground surface to total depth. If refusal is met before reaching the target boring depth, the boring will be offset 3 ft and attempted one more time to verify. Soil sampling using direct-push technology will be performed in accordance with the SOP #103 in the SAP-IW and SS-SAP. In general, four (4) soil samples for chemical analysis will be collected from each direct-push boring. One (1) soil sample will be collected from each of the following targeted lithologic zones:

Surface Soil Zone

A surface soil sample will be collected from ground surface to 0.5 ft bgs. These samples are intended to characterize the surface soils at the CFI Site and to determine if, where, and to what extent contamination from aerial and/or erosional deposits from the operations of the CFI exists.

Ash Deposit Zone

A grab sample of the ash/cinder material will be collected from the middle of the ash deposit zone. Based upon the thickness of the ash deposit zone the field geologist may collect additional samples. The ash deposit zone sample will vary in depth and vertical thickness depending on boring location. In general the ash deposit zone is shallower and thicker toward the top of the floodplain slope becoming deeper and

thinner toward the toe of the floodplain slope and on the Kansas River floodplain. These samples are intended to characterize the ash deposit zone and to determine the horizontal and vertical extent of contamination related to the ash deposits at the CFI Site.

Soil Below Ash Zone

A subsurface soil sample will be collected from immediately below the ash deposit zone. This sample will be collected from the first one (1) ft of subsurface soil immediately below the ash deposit zone. These samples are intended to characterize the soil below the ash deposit zone, to determine if contamination is leaching from the ash deposit zone, and, if so, what the horizontal and vertical extent of leaching-related contamination is.

Soil 6 Ft to 10 Ft Below Ash Zone

An additional subsurface soil sample will be collected from below the ash deposit zone. A sample will be collected from an interval of 6 ft to 10 ft below the ash deposit zone. The actual depth of sample collection will be based on PID readings and any visual indicators of possible contamination such as soil staining. These samples are intended to characterize the soil below the ash deposit zone, to determine if contamination is leaching from the ash deposit zone, and, if so, what the horizontal and vertical extent of leaching related contamination is.

If there are direct-push borings in which there is not a visually discernible ash deposit zone present, the BMcD PM and USACE-CENWK PM will be contacted to determine the number of samples and sampling intervals that will be collected.

The field geologist will prepare a lithologic log of each direct-push boring per SOP #508 in the SAP-IW and SS-SAP and will screen the soil from ground surface to the bottom of borehole using a photo ionization detector PID. The field geologist will use the PID screening results, visual staining (if present), and best judgment in selecting where to collect soil samples within these zones. The field geologist will also have the discretion to collect additional samples if elevated PID screening results are encountered or staining are observed.

Some sample locations located on the floodplain slope may be inaccessible with a direct-push rig due to the steepness of the slope. At these locations soil samples will be collected from the lithologic zones using a stainless-steel, hollow-core barrel, hand auger sampler. Soil samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. However, it is possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation (see Section 6.3.4).

See Table 6-7 for specific sampling and labeling requirements for Phase II direct-push soil sampling activities.

Phase II soil sampling locations are biased toward the portion of the Kansas River floodplain that lies to the south of the toe of the slope to better delineate the distal extent of possible incinerator ash.

6.3.5.3.2 Collection of Groundwater Samples

Following the collection of the soil samples, sixteen (16) selected direct-push borings (DP-25 through DP-40) will be advanced to the water table. Groundwater samples will be collected at the proposed locations along the sampling transect lines from the floodplain slope, at the toe of the floodplain, and on the Kansas River floodplain (Figure 6-5). Sampling transect lines will be laid out by field personnel using a measuring wheel, tape measure, and compass. Boring locations will be marked out using stakes. At each boring location, a single groundwater samples will be collected form the first groundwater encountered. Groundwater sampling using direct-push technology will be performed in accordance with the SOP #209 in the SAP-IW and SS-SAP. Groundwater samples will be collected from each of these selected direct-push borings for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. Groundwater samples collected for TAL metals (23 elements) will be filtered in the field prior to preservation and shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis. However, it is possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation (see Section 6.3.4).

See Table 6-7 for specific sampling and labeling requirements for Phase II direct-push groundwater sampling activities.

Phase II groundwater sampling is biased towards the toe of the slope and the Kansas River floodplain to better delineate the nature and extent of groundwater contamination.

6.3.5.4 Installation of Monitoring Wells

The need for and the number and location of monitoring wells will be determined by the BMcD PM and USACE-CENWK PM following the data evaluation of sampling results from the Phase I and Phase II field activities. If needed, all monitoring wells will be installed within the same water-bearing unit at the CFI Site at similar depths a groundwater samples collected during Phase I and Phase II. All monitoring wells will be installed to an approximate depth of 30 ft bgs using hollow stem augers and developed in accordance with SOP #506 provided in the SAP-IW and SS-SAP and the USACE *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Sites*, EM1110-1-4000

(USACE, 1998). A typical monitoring well construction diagram which includes well construction data is illustrated on Figure 6-6.

6.3.5.5 Monitoring Well Sampling

If monitoring wells are installed, four (4) monitoring well groundwater sampling events will be conducted including one baseline sampling event and three quarterly sampling events. Water level and total depth measurements will be collected at all monitoring wells during each of the four rounds of monitoring well groundwater sampling. Water levels and total depths will be collected in accordance with the SOP #201 provided in the SAP-IW and SS-SAP. These monitoring wells will be sampled using low-flow purging and sampling protocol. Low-flow sampling will be performed in accordance with the SOP #205 provided in the SAP-IW and SS-SAP based on the revised SOP for groundwater low-flow purging (USACE-CENWK, 2002). Groundwater samples will be collected from each monitoring well for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals (23 elements), MeHg, SVOCs (phenols and PAHs), and dioxins/furans. However, it is possible that some of these analytes will be dropped from the analytical suite as a result of the Phase I and Phase II data evaluations. Water quality field parameters of temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP) will be measured and recorded in the field during all monitoring well groundwater sampling events. Additionally, during the baseline sampling event, groundwater samples will also be collected for the evaluation of water quality laboratory parameters (alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and total organic carbon [TOC]).

See Table 6-8 for sampling and labeling requirements for monitoring well sampling activities.

6.3.5.6 Aquifer Characterization

If monitoring wells are installed, pneumatic slug testing will be performed on all monitoring wells installed at the CFI Site to better define the hydrogeologic properties of the aquifer. Pneumatic slug testing will be performed in the interval with the highest permeability as indicated on geologic boring logs. Data collected from the pneumatic slug tests will be uploaded into AQTESOLV Professional 4.5, a hydrogeologic software program to determine the hydraulic conductivity, transmissivity, and storativity of the aquifer. Pneumatic slug testing will be performed in conjunction with the baseline monitoring well groundwater sampling event. Slug testing will be performed in accordance with the SOP #509 detailed in the SAP-IW and SS-SAP.

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7.0 PROJECT SCHEDULE

A project schedule of the activities discussed within this RI/FS WP has been prepared and is provided as Figure 7-1.

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8.0 PROJECT MANAGEMENT

8.1 PROJECT ORGANIZATION

This section of the RI/FS WP describes key project organizations and personnel. Figure 8-1 provides a project organization chart for the CFI project, showing key personnel and lines of authority.

8.1.1 Fort Riley PWE

Ms. Andrea Austin is the Fort Riley PWE PM for this project and will serve as the primary point of contact (POC) for Fort Riley. The DA is the lead agency for the post. The Fort Riley PWE is responsible for implementation of the IRP program at the Post. During field activities, the Fort Riley PWE, USACE-CENWK, KDHE, LBG, BMcD, and any other involved subcontractors will participate in periodic conference calls, as needed.

8.1.2 USACE-CENWK

Mr. Brian Hughes is the USACE-CENWK PM for this project and will be the primary POC for contractual and technical matters. Fort Riley PWE has contracted with the USACE to coordinate and provide oversight for the IRP program.

8.1.3 United States Army Environmental Command (USAEC)

Ms. Judith Keith is the USAEC PM. USAEC focuses on supporting United States Army Installations in all facets of environmental programs and environmental sustainability. This includes managing environmental restoration programs at installations, environmental reporting, funding execution, information management, and analyzing environmental legislation and regulations.

8.1.4 USEPA

Mr. Amer Safadi is the USEPA PM. The USEPA will provide federal regulatory oversight for the CFI RI/FS.

8.1.5 KDHE

Mr. Travis Daneke, Professional Geologist (PG) is the KDHE PM. The KDHE will provide regulatory oversight for the State of Kansas for the CFI RI/FS.

8.1.6 LBG

Mr. Dennis McGrath, PG is the LBG PM. LBG has a contract through which environmental investigations are being performed. For this effort BMcD will report directly to the USACE-CENWK, but will inform LBG of significant project activities at Fort Riley. LBG's role on this project is primarily

administrative in nature and LBG will not have a day-to-day role in the technical elements; however, LBG will perform independent QC reviews of all project planning and reporting documents at all phases of the project.

8.1.7 BMcD

8.1.7.1 Program Manager (PGM)

Mr. Tracy Cooley, PG will serve as the BMcD PGM. Mr. Cooley is responsible for fulfillment of contract terms and oversight of operations to verify that all legal and safety requirements are met. Mr. Cooley will also be responsible to keep the project on schedule and with in budget and communicate with all interested parties regarding progress toward specified goals.

8.1.7.2 PM

Mr. Ed Lindgren, PG will serve as the BMcD PM. Mr. Lindgren is responsible for ensuring that project activities satisfy the requirements of the USACE SOW. To achieve this, Mr. Lindgren is responsible for maintaining staffing and is responsible for assigning personnel qualified to perform each activity. He is also responsible for reviewing submittals prior to or in conjunction with the QC Team to ensure that project-specific requirements are appropriately addressed. Mr. Lindgren will establish and maintain the quality file for the project. He is also responsible for reviewing Daily Quality Control Reports (DQCRs).

8.1.7.3 Field Site Manager (FSM)

The FSM will be identified prior to the start of field activities. The FSM is responsible for supervising all field investigation activities. The FSM reports directly to the BMcD PM. The FSM will have direct responsibility for field activities and for continued daily adherence to the quality standards set forth in the SAP-IW and SS-SAP.

8.1.7.4 Project Safety and Health Manager (SHM)

Mr. Eric Wenger, Certified Industrial Hygienist (CIH) will serve as the SHM for this project. Mr. Wenger, CIH will provide professional support by reviewing all health and safety programs as they apply to this project. The SHM will approve the IW-APP/SSHP, Addendum No. 2 to the IW-APP/SSHP, and all modifications to the plan as they affect the health and safety of field personnel. The SHM is responsible for providing professional health and safety support and oversight management to the Site Safety and Health Officer (SSHO). The SHM will review and provide support in all concerns regarding the health and safety of field personnel assigned to this project. Periodic field audits of the project work site may be conducted by the SHM to evaluate the adequacy of the program and implement any necessary

changes. Any audits performed by the SHM will be submitted to the USACE-CENWK Project CIH for review.

8.1.7.5 SSHO

A SSHO will be identified prior to the start of field activities. Responsibilities of the SSHO are discussed fully in the IW-APP/SSHP and Addendum No. 2 to the IW-APP/SSHP. The SSHO will be responsible for decisions regarding the immediate safety of investigation personnel and will report to the SHM, FSM, and BMcD PM.

The SSHO is responsible for overseeing personnel on the site, maintaining proper medical surveillance, providing hazard communication information, training employees in safe operating procedures, and advising the SHM and BMcD PM on matters concerning the health and safety of employees or the public. The SSHO may be required to perform various types of area or personnel monitoring to verify worker exposure and ensure the proper selection of personal protective equipment. The SSHO should be consulted before any changes in the recommended procedures or levels of protective clothing are made.

8.1.7.6 Project Chemist

The Project Chemist oversees the activities involving the field procedures for chemical samples, laboratory analyses, chemical sample documentation procedures, and tracking of chemical samples. The chemist also coordinates data validation of analytical laboratory deliverables. Ms. Shauna Lawrence will serve as the Project Chemist for the CFI Site RI/FS activities.

The project chemist often serves as the POC for subcontracted analytical laboratories with responsibilities as described below:

- Verify appropriate analyses to achieve project DQOs;
- Estimate costs for analytical services for any subcontracted lab services;
- Prepare purchase orders/authorizations for any subcontracted lab services;
- Schedule analytical services and order adequate/appropriate sample containers;
- Confirm sample receipt and laboratory log-in;
- Answer questions from the laboratory concerning sample anomalies and coordinate resolution of data evaluation issues between LBG/BMcD and the laboratory;

- Track the receipt of deliverables; and
- Inform the QC Director and BMcD PM of the project status and any potential lab problems that may jeopardize the quality of project data.

8.1.7.7 Project Team

The LBG/BMcD Project Team will be experienced in site investigations and will have shown technical proficiency in their respective professional areas of expertise. They will be familiar with internal review processes and specific details for this project. Members of the LBG/BMcD Project Team are responsible for conducting project work in the field or in the office. Their responsibilities include:

- Preparing planning documents and reports;
- Conducting field work;
- Reporting progress and problems to the BMcD PM;
- Implementing and/or recommending corrective actions regarding project activities to the BMcD PM; and
- Reviewing and correcting their own work prior to submittal to the PM.

The members of the LBG/BMcD Project Team have the authority to take the following actions:

- Require or perform "on-the-spot" corrections of deficiencies found during project execution and
- Implement and/or recommend corrective actions regarding project activities to the BMcD PM.

8.1.7.8 QC Manager

The QC Manager is Martha Hildebrandt, PG. Ms. Hildebrandt, PG will provide technical QC, oversight, and direction for all aspects of the planning, execution, analyses, and reporting for the CFI Site. The QC Manager is the head of the QC Team and responsible for the following tasks:

- Meeting with the PM and/or Project Team at the start of the project to define and discuss the acceptability criteria for each process and procedure;
- Ensuring that proper QC protocols have been executed on the project prior to submittal of a document to USACE;

- Tracking QC activities to ensure that they have been properly documented;
- Consulting with the PM regarding progress of the project, QC activities, and any quality issues;
- Establishing QC policies and reviewing them for adequacy;
- Implementing other corrective actions regarding project staffing if necessary;
- Disapproving a project document prior to reproduction for submittal to the USACE if proper QC has not been implemented or if deficiencies exist;
- Scheduling quality reviews and audits, when needed, to determine if acceptability criteria have been satisfied;
- Ensuring that all tasks defined in the QCP are being conducted and establish corrective action processes where acceptability criteria have not been satisfied; and
- Documenting QCP activities using review forms and memos.

Ms. Martha Hildebrandt, PG will have ultimate authority and responsibility to verify that the analyses specified and procedures established by BMcD for the RI/FS satisfy the DQOs discussed in Section 4.0.

8.1.7.9 QC Team

The QC Team is an organization of assigned technical specialists, called QC Inspectors, with no role in actual conduct of the project. The QC Inspectors will be technical experts within their respective disciplines, and will be responsible for evaluating products (documents and fieldwork) within their areas of expertise. The QC Team members that may be used for this project are presented in Figure 8-2. The QC Team is to provide checks and verification that the project is being conducted in accordance with applicable protocols and criteria, and in a quality manner. QC Team members will be experienced in similar projects and will have shown technical proficiency in their respective professional areas of expertise. The QC Team will be familiar with QC review processes and their implementation. Independent QC of field activities will not be performed for this project unless the USACE PM, LBG PM, or BMcD PM deem it necessary. If deemed necessary, the QC Team will document their respective reviews by field checklists, entries into site logbooks, QC trip reports, or QC reports.

8.1.8 Subcontractors

The subcontractors that will be used for this project are presented in Figure 8-3.

8.1.8.1 Analytical Laboratories

8.1.8.1.1 TestAmerica – West Sacramento

TestAmerica is the primary analytical laboratory for the analysis of soil, sediment, surface water, and groundwater samples for BTEX, TPH-GRO, TPH-DRO, TAL Metals (23 elements), SVOCs (phenols and PAHs), dioxins/furans, and natural attenuation parameters (alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and TOC). TestAmerica is accredited under the ELAP and certified by the state of Kansas. TestAmerica will be contracted by BMcD. The address and POC for TestAmerica is:

TestAmerica – West Sacramento
880 Riverside Parkway
West Sacramento, California 95605
POC: Ms. Karen Dahl (916-374-4384)

8.1.8.1.2 Brooks Rand Labs

BRL is the primary specialty laboratory for the analysis of soil, sediment, surface water, and groundwater samples for MeHg. BRL is accredited under ELAP and certified by the state of Kansas. BRL will be contracted by BMcD. The address and POC for BRL is:

Brooks Rand Labs
3958 6th Avenue NW
Seattle, Washington 98107
POC: Tiffany Stillwater (206-632-6206)

8.1.8.2 Direct-Push Contractor

Environmental Priority Service, Inc. (EPS) is the primary direct push contractor. EPS will collect soil and groundwater water samples using track or truck mounted direct-push rig. The address and POC for EPS is:

Environmental Priority Service, Inc.
7193 East Benfield Road
Salina, Kansas 67401
POC: Mr. Pat Martin (785-823-6285)

8.1.8.3 Drilling and Monitoring Well Installation Contractor

Razek Environmental, LLC (Razek) is the primary contractor for drilling and monitoring well installation. Razek will drilling, install, and develop monitoring wells. The address and POC for Razek is:

Razek Environmental, LLC
27537 Cold Water Road
Louisburg, Kansas 66053
POC: Mr. Tony Poulter (913-837-2315)

8.1.8.4 Earthwork and Brush Removal Contractor

Greenfield Contractors, Inc. (Greenfield) is the primary contractor for earthwork and brush removal activities. The address and POC for Greenfield is:

Greenfield Contractors, Inc.
2775 Arnold Road, Suite D
Salina, Kansas 67401
POC: Mr. Tim Pace (785-822-0900)

8.1.8.5 Surveying Contractor

Merestone Surveying Company is the primary contractor for surveying activities. Merestone Surveying Company is a register land surveyor in Kansas and will survey sample and monitoring wells locations and elevations. The address and POC for C-B is:

Merestone Surveying Company
1224 North Andover Road, Suite 100
Andover, Kansas 67002
POC: Mr. Mark Carlson (316-425-7770)

8.2 TEAM MEETINGS AND REPORTING

8.2.1 DQCRs

The FSM will be responsible for ensuring that the CFI sampling team record daily activities on the standard DQCR form. A DQCR will be submitted on each day of field activities. Chain of Custody (COC) Forms will be submitted on each day of sampling. The DQCR will be completed daily and submitted in draft form to the BMcD PM no later than 0800 on the day following the fieldwork. The BMcD PM will review the document, and then forward it on to LBG, Fort Riley PWE and USACE-CENWK PM for review. The reports will be reviewed by LBG, Fort Riley PWE, and USACE-CENWK. Comments will be provided as appropriate to the BMcD PM within 24 hours of submittal or the next business day. BMcD will correct the reports in accordance with the comments. A copy of the DQCR form is included in the SAP-IW and SS-SAP.

8.2.2 Monthly Progress Reports

BMcD will submit a progress report each month to the Fort Riley PWE PM and USACE-CENWK PM. These progress reports will be submitted by the 15th of each month and will include the following information:

- Progress made during the reporting period;
- Problem areas and recommended solutions (or outstanding issues);
- Any corrective actions undertaken and their effects;
- Key personnel changes;
- All significant phone conversations that involve major project decisions, including those in which USACE-CENWK participates;
- Anticipated activities for the next reporting period; and
- Updated schedule.

8.2.3 Team Meetings

Routine Project Team meetings will be held in the field and in the office during the duration of the project to discuss project activities, progress, and schedule.

The PM will hold a project kick-off meeting for the Project Team. In the kick-off meeting, the following items, as applicable, will be discussed:

- Specific responsibilities and/or tasks of each Project Team member;
- Project schedules and budgets;
- General review and overview of applicable site plan documents;
- Planned field activities;
- Planned office activities;
- Internal reporting requirements;

- Review assignments;
- Required forms;
- Required project submittals; and
- Standard format of project documents.

The PM will hold routine project status meetings in the office as necessary following the project kick-off meeting, during field work activities, and during data evaluation and report preparation stages of the project.

The FSM will be responsible for holding project meetings with the Project Team and subcontractors prior to initiation of field work. These meetings, at a minimum, will address the following items:

- Scheduled activities and assigned personnel;
- Health and safety issues associated with scheduled activities;
- Problems/deficiencies noted in previous field activities and how they will be corrected; and
- Any other information pertinent to field or project activities.

The FSM will document all field Project Team meetings and persons who attended on the DQCRs.

8.3 REVIEWS AND CORRECTIVE ACTIONS

8.3.1 Field Reviews

Reviews will be a part of the PM's overall project plan for the project. Reviews during field activities will be conducted by the BMcD FSM. The BMcD FSM will have primary responsibility for QC of field activities which includes; DQCRs, COC documents, field checklists, etc. From the office, the Project Team will review appropriate field documentation as it is generated. The QC Team will also conduct independent reviews of the field documentation. Reviews of field activities will include the following items:

- Daily reviews of field documentation;
- Daily reviews of field activities and procedures;

- Daily reviews of health and safety procedures; and

- Reviews (as required) of field QC checklists.
  Field QC checklists will be completed for each applicable task performed during that particular day of work. A field QC checklist for each task will be completed at a frequency indicted at the top of each field QC checklist.

The BMcD FSM will also review field procedures at the beginning of each new field activity. The BMcD FSM will document all field reviews and corrective actions on the DQCR form, and provide the documentation to the PM.

Independent QC of field activities will not be performed unless the USACE PM, LBG PM, or BMcD PM deem it is necessary. If inspections associated with field activities or processes are deemed necessary, they will be conducted by members of the QC Team and documented through field checklists and a final trip report.

8.3.2 Office Reviews

The Project Chemist will review the COC documents for samples sent to the analytical laboratory to ensure completeness and accuracy (*e.g.,* proper sample names and analysis, site locations and other applicable information). The COCs will also be checked to ensure that the necessary QC samples, if any, were collected. The Project Chemist will maintain close and continuous contact with the laboratory project manager to verify receipt of samples, timely analysis, appropriate sample batching, and receipt of correct documentation. The Project Chemist will also review analytical data from the laboratory to ensure that data packages are complete.

8.3.3 Report Reviews

Office reviews of reports by Project Team members will be conducted prior to submitting the report to the Fort Riley PWE and USACE-CENWK. Office reviews of analytical data will be conducted as described in the SAP-IW and SS-SAP.

8.3.4 Corrective Actions

Corrective actions will be taken when deficiencies are identified. Corrective actions will be determined based on the specific deficiency and the impact of the deficiency on the technical quality of the project. The QC Team will use checklists to assist in assuring that project products (both documents and field activities) are being performed properly. The BMcD FSM will report deficiencies and corrective actions to the BMcD QC Managers and the BMcD PM. Since some deficiencies are more serious than others,

each deficiency will be reviewed to determine the corrective action that is most appropriate. Factors to be considered in this evaluation include the cause of the deficiency and the impact of the deficiency on project goals. An assessment will be made regarding any effect of the deficiency on project budgets, schedules, and technical adequacy; and the appropriate corrective action will be determined. A list of deficiencies and proposed corrective actions will also be provided to the LBG PM for review and approval.

Deficiencies detected during execution of the project will be fully explained to the Project Team by the BMcD PM, either at the time the deficiency is noted or at the scheduled Project Team meetings. If possible, deficiencies will be corrected "on-the-spot" in accordance with the QC Managers direction. Deficiencies related to safety and health will be corrected immediately to protect worker safety and health. For deficiencies that have a significant impact on the project, an appropriate corrective action will be determined and implemented by the BMcD PM. QC personnel will document deficiencies and how they are corrected.

The BMcD PM will be responsible for informing the LBG PM of deficiencies through external reporting and direct correspondence. The LBG PM will be informed of any critical and/or major deficiencies in the execution of the project, which may significantly affect the technical quality of the project or the professional relationship between LBG, LBG Subcontractors, and USACE. The LBG PM is then responsible for informing the USACE PM of any and all deficiencies found and the corrective actions taken.

In the field, the BMcD FSM will have primary responsibility for ensuring that the field activities are executed in accordance with the project plans. If a deficiency is noted, the BMcD FSM will be responsible for implementing "on-the-spot" corrections, as appropriate, to address the deficiency and to minimize future occurrence of a similar deficiency. If a deficiency cannot be easily corrected "on-the-spot", the BMcD FSM will work directly with the BMcD PM so the situation can be fully addressed and resolved. The QC Team in the office will also review appropriate field documentation to ensure that field activities are properly executed. In the office, Project Team members will be responsible for checking their work products prior to submission to the BMcD PM for review. The BMcD PM and the QC Team will be responsible for reviewing completed work products and providing Project Team members with comments, corrections, and revisions.

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TABLES

Table 2-1
Listed and Rare Species Occurring and Potentially Occurring in the Fort Riley Area
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Common Name	Scientific Name	Federal Status	State Status	Known to Occur in Geary County	Known to Occur in Riley County
American Burying Beetle	*Nicrophorus americanus*	E	E	Yes	Yes
Black Rail	*Laterallus jamaicensis*	None	SINC	No	Yes
Black Tern	*Chlidonias niger*	None	SINC	Yes	Yes
Bobolink	*Dolichonyx oryzivorus*	None	SINC	No	Yes
Common Shiner	*Luxilus cornutus*	None	SINC	Yes	No
Eastern Hognose Snake	*Heterodon platirhinos*	None	SINC	Yes	Yes
Eastern Spotted Skunk	*Spilogale putorius*	None	T	Yes	Yes
Eskimo Cerlew	*Numenius borealis*	E	E	Yes	Yes
Franklin's Ground Squirrel	*Spermophilus franklinii*	None	SINC	No	Yes
Golden Eagle	*Aquila chrysaetos*	None	SINC	Yes	Yes
Henslow's Sparrow	*Ammodramus henslowii*	None	SINC	Yes	Yes
Highfin Carpsucker	*Carpiodes velifer*	None	SINC	No	Yes
Least Tern	*Sterna antillarum*	E	E	Yes-Critical Habitat Designated[1]	Yes-Critical Habitat Designated[1]
Long-billed Curlew	*Numenius americanus*	None	SINC	No	Yes
Piping Plover	*Charadrius melodus*	T	T	Yes-Critical Habitat Designated[1]	Yes-Critical Habitat Designated[1]
Plains Minnow	*Hybognathus placitus*	None	T	Yes-Temporary Critical Habitat Designated[2]	Yes-Temporary Critical Habitat Designated[2]
Shoal Chub	*Macrhybopsis histoma*	None	T	Yes-Temporary Critical Habitat Designated[3]	No
Short-Eared Owl	*Asio flammeus*	None	SINC	Yes	Yes
Silver Chub	*Macrhybopsis storeriana*	None	E	Yes-Critical Habitat Designated[4]	Yes
Snowy Plover	*Charadrius alexandrinus*	None	T	Yes	Yes
Southern Bog Lemming	*Synaptomys copperi*	None	SINC	No	Yes
Sturgeon Chub	*Macrhybopsis gelida*	None	T	Yes-Critical Habitat Designated[5]	Yes-Critical Habitat Designated[5]
Timber Rattlesnake	*Crotalus horridus*	None	SINC	Yes	Yes
Topeka Shiner	*Notropis topeka*	E	T	Yes-Critical Habitat Designated[6]	Yes-Critical Habitat Designated[6]
Western Hognosed Snake	*Heterodon nasicus*	None	SINC	Yes	Yes
Whip-Poor-Will	*Caprimulgus vociferus*	None	SINC	Yes	Yes
Whooping Crane	*Grus americana*	E	E	No	Yes
Yellow-throated Warbler	*Dendroica dominica*	None	SINC	No	Yes

Notes:
[1] All the waters within a corridor along the main stem of the Kansas River from the confluence of the Republican River and Smoky Hill River on Fort Riley in Geary County to the confluence of the Missouri River in Kansas City,
[2] The Kansas River in Geary and Riley counties.
[3] The Kansas River in Geary County.
[4] The Kansas River from the confluence of the Republican and Smoky Hill Rivers to the Missouri River (Sec. 1 & 2, T11S, R25E).
[5] The main stem of the Kansas River from its start at the confluence of the Republican River and Smoky Hill River on Fort Riley in Geary County to the confluence of the Missouri River in Kansas City, Wyandotte County.
[6] Cary Creek and its tributaries in Dickinson County from where it crosses the Dickinson/Geary County line (Sec. 6, T14S, R5E) upstream to its headwaters (Sec. 33, T15S, R3E); Thomas Creek and Dry Creek in Geary County; Little Sevenmile Creek in Riley County; Deep Creek main stem in Riley County from where it crosses the Riley/Wabaunsee County line (Sec. 22, T10S, R9E) upstream to Interstate Highway 70 (Sec. 25, T11S, R9E).

E = Endangered SINC = Species in Need of Conservation T = Threatened

Table 6-1
Background Soil Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters		QC Requirements		
					TAL Metals[1]	SVOC[2]	Field Duplicate (10%)	MS/MSD (5%)	Rinsate
CFI OU 007	BG01	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG02	SB01	0 - 0.5'	Soil	X	X	SB11		
		SB02	3 - 4'	Soil	X	X			
	BG03	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG04	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X	SB22		
	BG05	SB01	0 - 0.5'	Soil	X	X			ERB01
		SB02	3 - 4'	Soil	X	X			
	BG06	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG07	SB01	0 - 0.5'	Soil	X	X		SB01X	
		SB02	3 - 4'	Soil	X	X			
	BG08	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG09	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG10	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X			
	BG11	SB01	0 - 0.5'	Soil	X	X	SB11		
		SB02	3 - 4'	Soil	X	X			
	BG12	SB01	0 - 0.5'	Soil	X	X			
		SB02	3 - 4'	Soil	X	X		SB02X	

Table 6-1
Background Soil Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters		QC Requirements		
					TAL Metals[1]	SVOC[2]	Field Duplicate (10%)	MS/MSD (5%)	Rinsate

Notes:
1. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
2. SVOC samples will be analyzed using analytical method SW-846 8270C.

BG - background
bgs - below ground surface
CFI - WWI Incinerator, NW Camp Funston
ERB - equipment rinsate blank
MS - matrix spike
MSD - matrix spike duplicate
OU - operational unit
QC - quality control
SB - soil boring
SVOC - semi-volatile organic compound
TAL - target analyte list

Table 6-2
Phase I Surface Soil and Stream Sediment Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters							QC Requirements			
					BTEX[1]	TPH - GRO[2]	TPH - DRO[3]	TAL Metals[4]	MeHg[5]	SVOC[6]	Dioxins / Furans[7]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[8] (10%)	Rinsate
CFI OU 007	SS01	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X		SS01X		
	SS02	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X				
	SS03	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X	SS11			
	SS04	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X			FB01	
	SS05	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X				ERB01
	SD01	SD01	NA	Stream Sediment	X	X	X	X	X	X	X		SD01X		
	SD02	SD01	NA	Stream Sediment	X	X	X	X	X	X	X	SD11			
	SD03	SD01	NA	Stream Sediment	X	X	X	X	X	X	X			FB01	

Notes:
1. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analytical method SW-846 8260B.
2. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
3. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
4. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
5. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
6. SVOC samples will be analyzed using analytical method SW-846 8270C.
7. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
8. Field blank samples only required for analysis of MeHg.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
ERB - equipment rinsate blank
GRO - gasoline range organics
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SS - surface soil
SD - sediment
SVOC - semi-volatile organic compound
TAL - target analyte list
TPH - total petroleum hydrocarbon

Table 6-3
Phase I Surface Water Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters							QC Requirements			
					BTEX[1]	TPH - GRO[2]	TPH - DRO[3]	TAL Metals[4]	MeHg[5]	SVOC[6]	Dioxins / Furans[7]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[8] (10%)	Rinsate
CFI OU 007	SW01	SW01	NA	Surface Water	X	X	X	X	X	X	X		SW01X		
	SW02	SW01	NA	Surface Water	X	X	X	X	X	X	X	SW11		FB01	
	SW03	SW01	NA	Surface Water	X	X	X	X	X	X	X				ERB01

Notes:
1. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analtical method SW-846 8260B.
2. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
3. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
4. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
5. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
6. SVOC samples will be analyzed using analytical method SW-846 8270C.
7. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
8. Field blank samples only required for analysis of MeHg.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
ERB - equipment rinsate blank
GRO - gasoline range organics
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SW - surface water
SVOC - semi-volatile organic compound
TAL - target analyte list
TPH - total petroleum hydrocarbon

Table 6-4
Phase I Direct-Push Soil and Groundwater Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters							QC Requirements			
					BTEX[1]	TPH - GRO[2]	TPH - DRO[3]	TAL Metals[4]	MeHg[5]	SVOC[6]	Dioxins / Furans[7]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[8] (10%)	Rinsate[9]
CFI OU 007	DP01	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X	SB22			
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP02	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X		SB02X		
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP03	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X			FB01	
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				ERB01
	DP04	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X	SB33			
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP05	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X			FB01	
	DP06	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X		SB01X		
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP07	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X	SB11			
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X			FB01	
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP08	GW01	NA	Groundwater	X	X	X	X	X	X	X		GW01X		
	DP09	GW01	NA	Groundwater	X	X	X	X	X	X	X				ERB01
	DP10	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP11	GW01	NA	Groundwater	X	X	X	X	X	X	X			FB01	
	DP12	GW01	NA	Groundwater	X	X	X	X	X	X	X	GW11			

Table 6-4
Phase I Direct-Push Soil and Groundwater Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters							QC Requirements			
					BTEX[1]	TPH - GRO[2]	TPH - DRO[3]	TAL Metals[4]	MeHg[5]	SVOC[6]	Dioxins / Furans[7]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[8] (10%)	Rinsate[9]

Notes:
1. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analytical method SW-846 8260B.
2. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
3. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
4. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
5. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
6. SVOC samples will be analyzed using analytical method SW-846 8270C.
7. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
8. Field blank samples only required for analysis of MeHg.
9. Equipment rinsates will be collected, one from each sampling matrix tool.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
DP - direct-push
ERB - equipment rinsate blank
GRO - gasoline range organics
GW- groundwater
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SB - soil boring
SBA - soil below ash
SVOC - semi-volatile organic compound
TAL - target analytical list
TPH - total petroleum hydrocarbon

Table 6-5
Phase II Surface Soil and Stream Sediment Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins / Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate
CFI OU 007	SS06	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X		SS01X		
	SS07	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X			FB01	ERB01
	SS08	SS01	0 - 0.5'	Surface Soil	X	X	X	X	X	X	X	SS11			
	SD04	SD01	NA	Stream Sediment	X	X	X	X	X	X	X		SD01X		
	SD05	SD01	NA	Stream Sediment	X	X	X	X	X	X	X	SD11			
	SD06	SD01	NA	Stream Sediment	X	X	X	X	X	X	X			FB01	

Notes:
1. Based on the Phase I data evaluation some of these analytes may be dropped from the analytical suite.
2. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analtical method SW-846 8260B.
3. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
4. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
5. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
6. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
7. SVOC samples will be analyzed using analytical method SW-846 8270C.
8. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
9. Field blank samples only required for analysis of MeHg.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
ERB - equipment rinsate blank
GRO - gasoline range organics
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SS - surface soil
SD - sediment
SVOC - semi-volatile organic compound
TAL - target analyte list
TPH - total petroleum hydrocarbon

Table 6-6
Phase II Surface Water Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins / Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate
CFI OU 007	SW04	SW01	NA	Surface Water	X	X	X	X	X	X	X		SW01X		
	SW05	SW01	NA	Surface Water	X	X	X	X	X	X	X	SW11			
	SW06	SW01	NA	Surface Water	X	X	X	X	X	X	X			FB01	ERB01

Notes:
1. Based on the Phase I data evaluation some of these analytes may be dropped from the analytical suite.
2. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analtical method SW-846 8260B.
3. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
4. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
5. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
6. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
7. SVOC samples will be analyzed using analytical method SW-846 8270C.
8. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
9. Field blank samples only required for analysis of MeHg.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
ERB - equipment rinsate blank
GRO - gasoline range organics
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SW - surface water
SVOC - semi-volatile organic compound
TAL - target analyte list
TPH - total petroleum hydrocarbon

Table 6-7
Phase II Direct-Push Soil and Groundwater Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins / Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate[10]
CFI OU 007	DP13	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X	SB22			
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP14	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X		SB01X		
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP15	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X			FB01	
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP16	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X	SB11			
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				ERB01
	DP17	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X			FB01	
	DP18	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X		SB03X		
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP19	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP20	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X			FB01	
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X	SB33			
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				

Table 6-7
Phase II Direct-Push Soil and Groundwater Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins / Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate[10]
CFI OU 007	DP21	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP22	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X	SB11			
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X			FB01	
	DP23	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X		SB02X		
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X				
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X				
	DP24	SB01	0 - 0.5'	Soil	X	X	X	X	X	X	X				
		SB02	ASH	Soil	X	X	X	X	X	X	X				
		SB03	SBA 1'	Soil	X	X	X	X	X	X	X			FB01	
		SB04	SBA 6 -10'	Soil	X	X	X	X	X	X	X	SB44			
	DP25	GW01	NA	Groundwater	X	X	X	X	X	X	X	GW11			
	DP26	GW01	NA	Groundwater	X	X	X	X	X	X	X		GW01X		
	DP27	GW01	NA	Groundwater	X	X	X	X	X	X	X				ERB01
	DP28	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP29	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP30	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP31	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP32	GW01	NA	Groundwater	X	X	X	X	X	X	X			FB01	
	DP33	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP34	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP35	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP36	GW01	NA	Groundwater	X	X	X	X	X	X	X	GW11			
	DP37	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP38	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP39	GW01	NA	Groundwater	X	X	X	X	X	X	X				
	DP40	GW01	NA	Groundwater	X	X	X	X	X	X	X			FB01	

Table 6-7
Phase II Direct-Push Soil and Groundwater Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins / Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate[10]

Notes:
1. Based on the Phase I data evaluation some of these analytes may be dropped from the analytical suite.
2. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analytical method SW-846 8260B.
3. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
4. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
5. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
6. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
7. SVOC samples will be analyzed using analytical method SW-846 8270C.
8. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
9. Field blank samples only required for analysis of MeHg.
10. Equipment rinsates will be collected, one from each sampling matrix tool.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
DRO - diesel range organics
DP - direct-push
ERB - equipment rinsate blank
GRO - gasoline range organics
GW- groundwater
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
OU - operational unit
QC - quality control
SB - soil boring
SBA - soil below ash
SVOC - semi-volatile organic compound
TAL - target analytical list
TPH - total petroleum hydrocarbon

Table 6-8
Monitoring Well Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Inverval (bgs)	Matrix	Analytical Parameters[1]							QC Requirements			
					BTEX[2]	TPH - GRO[3]	TPH - DRO[4]	TAL Metals[5]	MeHg[6]	SVOC[7]	Dioxins/Furans[8]	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate
Baseline Event (Round 1)															
CFI OU 007	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X				ERB01
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X		GW01X		
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X			FB01	
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X	GW11			
Second Quarterly Event (Round 2)															
CFI OU 007	CFI-MWXX-XX*	GW02	NA	Groundwater	X	X	X	X	X	X	X				ERB02
	CFI-MWXX-XX*	GW02	NA	Groundwater	X	X	X	X	X	X	X		GW02X		
	CFI-MWXX-XX*	GW02	NA	Groundwater	X	X	X	X	X	X	X			FB02	
	CFI-MWXX-XX*	GW02	NA	Groundwater	X	X	X	X	X	X	X	GW22			
Third Quarterly Event (Round 3)															
CFI OU 007	CFI-MWXX-XX*	GW03	NA	Groundwater	X	X	X	X	X	X	X				ERB03
	CFI-MWXX-XX*	GW03	NA	Groundwater	X	X	X	X	X	X	X		GW03X		
	CFI-MWXX-XX*	GW03	NA	Groundwater	X	X	X	X	X	X	X			FB03	
	CFI-MWXX-XX*	GW03	NA	Groundwater	X	X	X	X	X	X	X	GW33			
Fourth Quarterly Event (Round 4)															
CFI OU 007	CFI-MWXX-XX*	GW04	NA	Groundwater	X	X	X	X	X	X	X				ERB04
	CFI-MWXX-XX*	GW04	NA	Groundwater	X	X	X	X	X	X	X		GW04X		
	CFI-MWXX-XX*	GW04	NA	Groundwater	X	X	X	X	X	X	X			FB04	
	CFI-MWXX-XX*	GW04	NA	Groundwater	X	X	X	X	X	X	X	GW44			

Notes:
* The need for and the number and location of monitoring wells will be determined by the BMcD PM and USACE-CENWK PM. The number on monitoring wells in this table represents generic monitoring well numbers.

1. Based on the Phase I data evaluation some of these analytes may be dropped from the analytical suite.
2. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analytical method SW-846 8260B.
3. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
4. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
5. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
6. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
7. SVOC samples will be analyzed using analytical method SW-846 8270C.
8. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
9. Field blank samples only required for analysis of MeHg.
10. TOC samples will be analyzed using analytical method SW-846 9060.
11. Alkalinity sample will be analyzed using analytical method SM 2320B.
12. Anions (chloride, nitrate, nitrite, and sulfate) will be analyzed using analytical method EPA 300.0.
13. Sulfide will be analyzed using analytical method EPA 9034.

bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CFI - WWI Incinerator, NW Camp Funston
Cond - specific conductivity
DO - dissolved oxygen
DRO - diesel range organics
ERB - equipment rinsate blank
GRO - gasoline range organics
GW- groundwater
NA - not applicable
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
MW - monitoring well
ORP - oxidation reduction potential
OU - operational unit
QC - quality control
SVOC - semi-volatile organic compound
TAL - target analyte list
Temp - temperature
TPH - total petroleum hydrocarbon
TOC - total organic carbon

Table 6-8
Monitoring Well Sampling Requirements
WWI Incinerator, NW Camp Funston (CFI) Site
Fort Riley, Kansas

Group Name	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	Water Quality Parameters												QC Requirements			
					Laboratory Measured Parameters							Field Measured Parameters								
							Anions[12]													
					TOC[10]	Alkalinity[11]	Chloride	Nitrate	Nitrite	Sulfate	Sulfide[13]	Temp	pH	Cond	DO	ORP	Field Duplicate (10%)	MS/MSD (5%)	Field Blank[9] (10%)	Rinsate
Baseline Event (Round 1)																				
CFI OU 007	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X	X	X	X	X	X				ERB01
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X	X	X	X	X	X		GW0X		
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X	X	X	X	X	X			FB01	
	CFI-MWXX-XX*	GW01	NA	Groundwater	X	X	X	X	X	X	X	X	X	X	X	X	GW11			
Second Quarterly Event (Round 2)																				
CFI OU 007	CFI-MWXX-XX*	GW02	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X				ERB02
	CFI-MWXX-XX*	GW02	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X		GW02X		
	CFI-MWXX-XX*	GW02	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X			FB02	
	CFI-MWXX-XX*	GW02	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X	GW22			
Third Quarterly Event (Round 3)																				
CFI OU 007	CFI-MWXX-XX*	GW03	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X				ERB03
	CFI-MWXX-XX*	GW03	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X		GW03X		
	CFI-MWXX-XX*	GW03	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X			FB03	
	CFI-MWXX-XX*	GW03	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X	GW33			
Fourth Quarterly Event (Round 4)																				
CFI OU 007	CFI-MWXX-XX*	GW04	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X				ERB04
	CFI-MWXX-XX*	GW04	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X		GW04X		
	CFI-MWXX-XX*	GW04	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X			FB04	
	CFI-MWXX-XX*	GW04	NA	Groundwater	NA	NA	NA	NA	NA	NA	NA	X	X	X	X	X	GW44			

Notes:
* The need for and the number and location of monitoring wells will be determined by the BMcD PM and USACE-CENWK PM. The number on monitoring wells in this table represents generic monitoring well numbers.
1. Based on the Phase I data evaluation some of these analytes may be dropped from the analytical suite.
2. A trip blank will accompany all sample coolers containing liquid BTEX samples. BTEX samples will be analyzed using analytical method SW-846 8260B.
3. A trip blank will accompany all sample coolers containing liquid TPH-GRO samples. TPH-GRO samples will be analyzed using analytical method SW-846 8260B.
4. TPH-DRO sample will be analyzed using analytical method SW-846 8015B.
5. TAL metals samples will be analyzed using analytical method SW-846 6010B and 7470A/7471A.
6. MeHg samples will be analyzed using analytical method EPA 1630 Modified.
7. SVOC samples will be analyzed using analytical method SW-846 8270C.
8. Dioxins/Furans samples will be analyzed using analytical method SW-846 8290.
9. Field blank samples only required for analysis of MeHg.
10. TOC samples will be analyzed using analytical method SW-846 9060.
11. Alkalinity sample will be analyzed using analytical method SM 2320B.
12. Anions (chloride, nitrate, nitrite, and sulfate) will be analyzed using analytical method EPA 300.0.
13. Sulfide will be analyzed using analytical method EPA 9034.

bgs - below ground surface
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NA - not applicable
MeHg - methyl mercury
MS - matrix spike
MSD - matrix spike duplicate
MW - monitoring well
ORP - oxidation reduction potential
OU - operational unit
QC - quality control
SVOC - semi-volatile organic compound
TAL - target analyte list
Temp - temperature
TPH - total petroleum hydrocarbon
TOC - total organic carbon

FIGURES

CUSTER HILL

CFI SITE

CAMP WHITSIDE

CAMP FUNSTON

CAMP FORSYTH

MAIN POST

MARSHALL ARMY AIRFIELD

Union Pacific Railroad

Kansas River

114

18

70

77

0 3,000

SCALE IN FEET

N

KANSAS

Fort Riley

Salina

Topeka

Wichita

Not to Scale

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Figure 2-1

GENERAL LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

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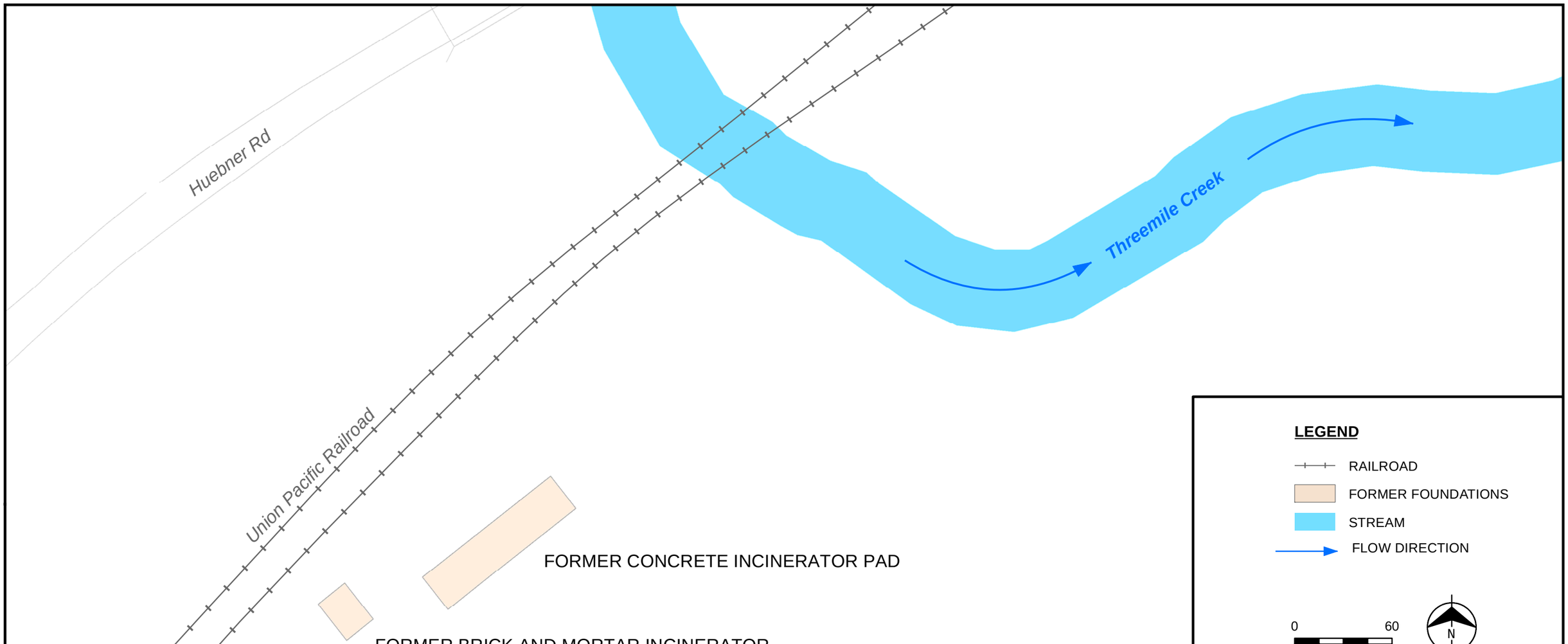

Figure 2-2
CFI SITE
GENERAL LOCATION MAP
CFI SITE-SPECIFIC SITE SAFETY
AND HEALTH PLAN
FORT RILEY, KANSAS

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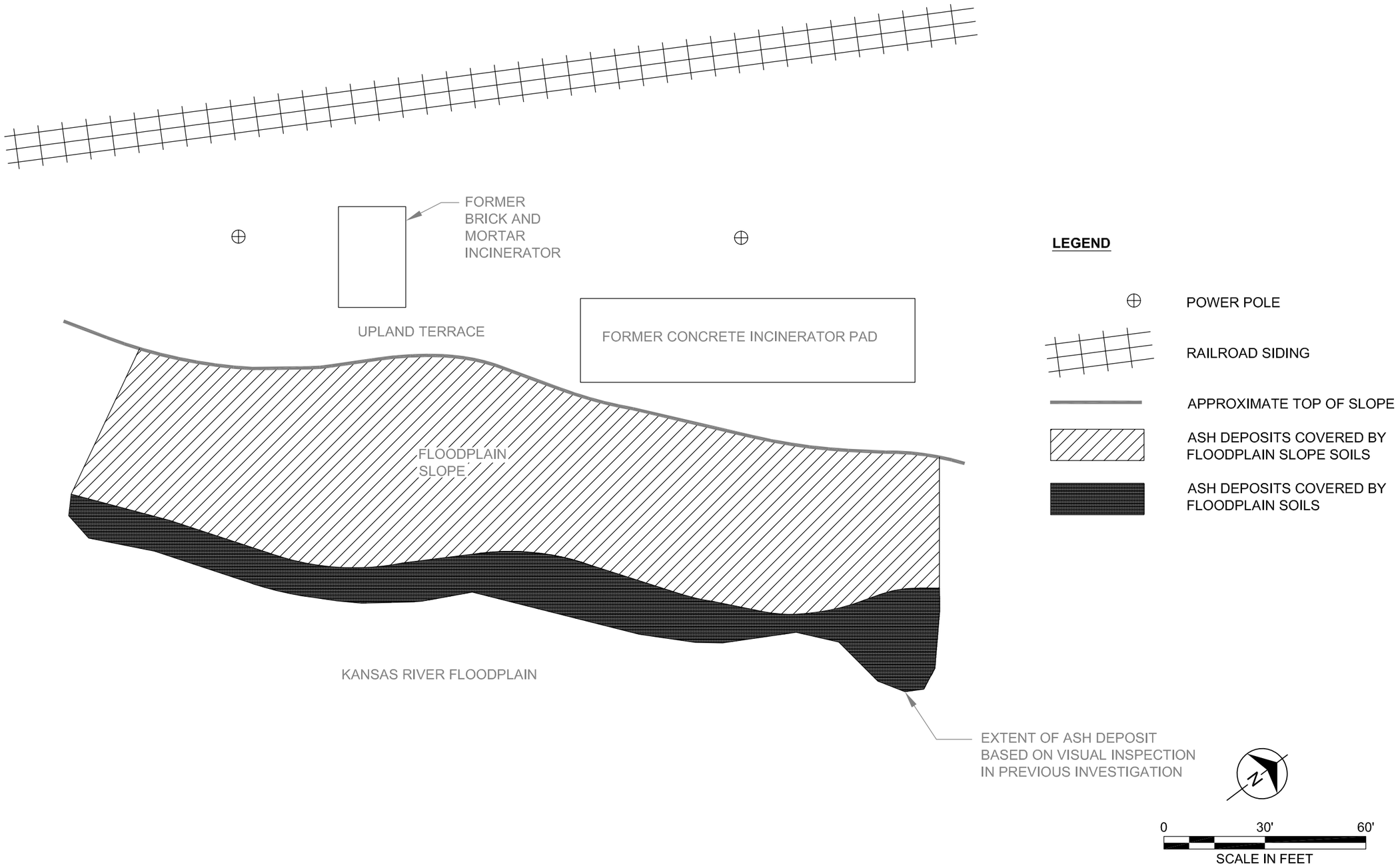

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Figure 2-3

CFI SITE LOCATION MAP

CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

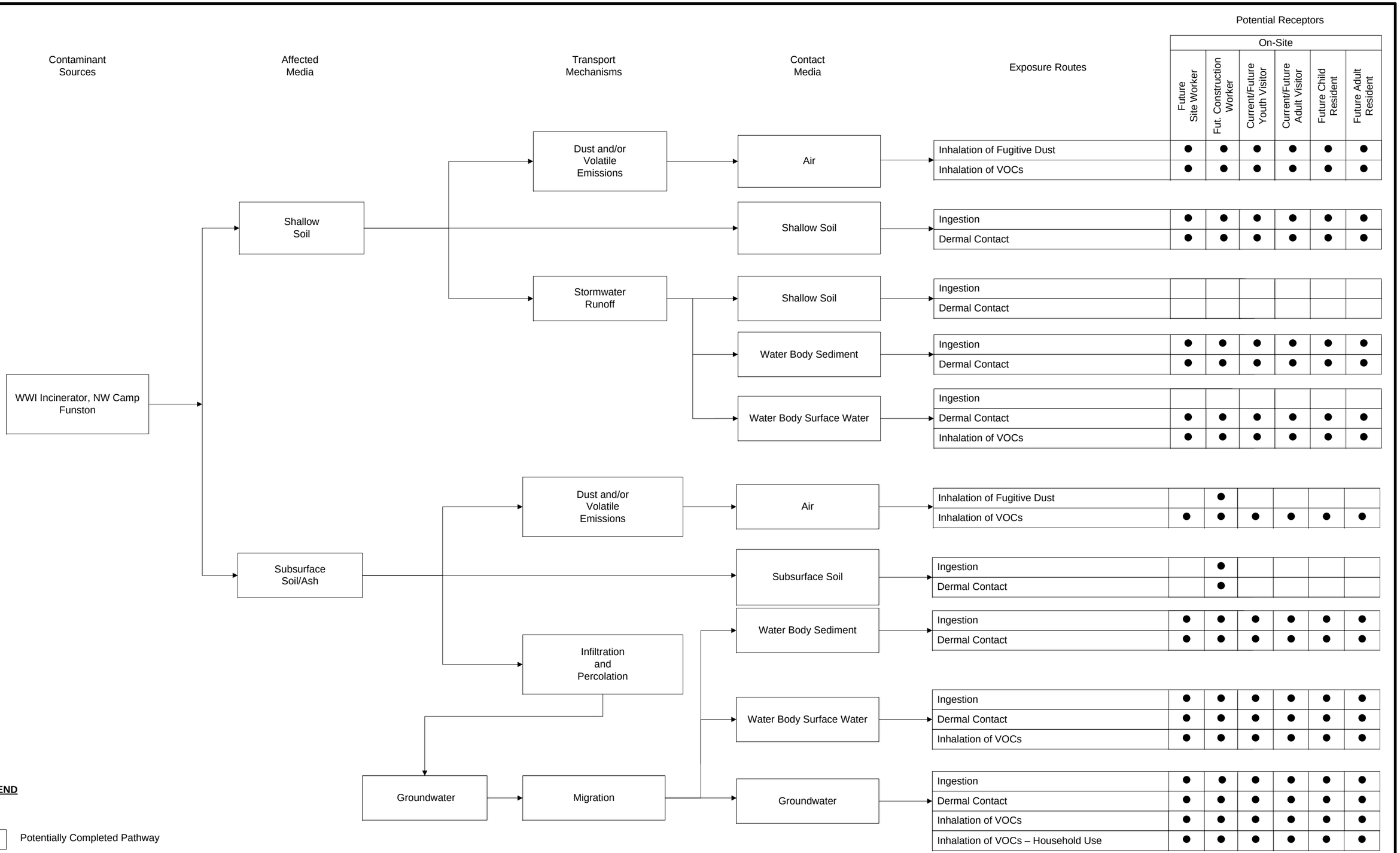
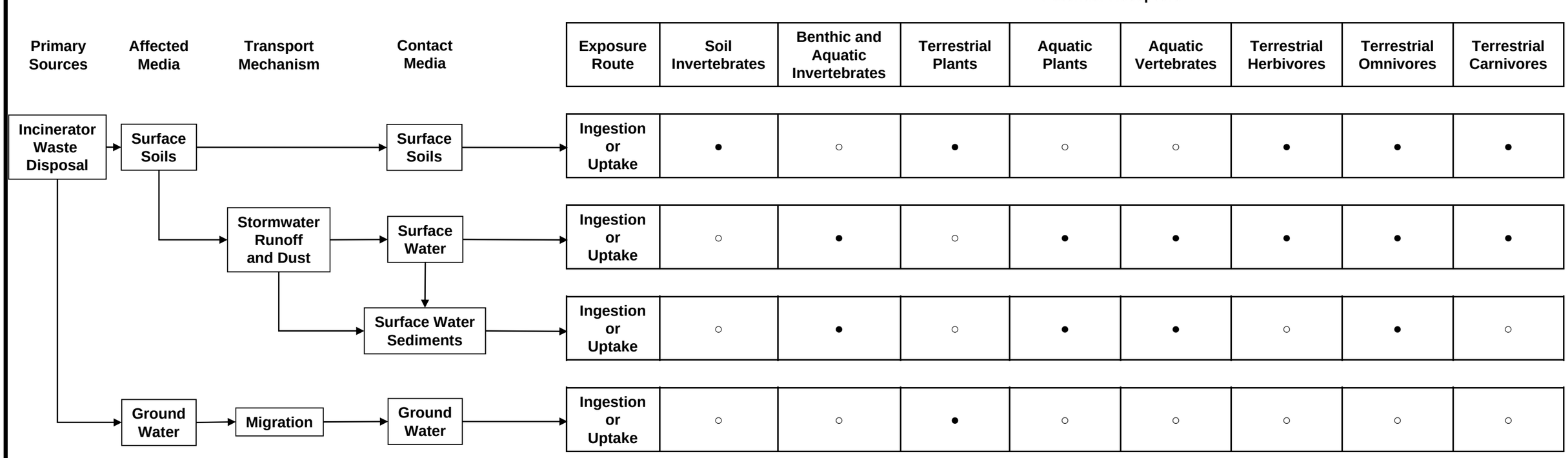


Figure 3-1
HUMAN HEALTH
CONCEPTUAL SITE MODEL
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS



Potential Receptors

Exposure Route	Soil Invertebrates	Benthic and Aquatic Invertebrates	Terrestrial Plants	Aquatic Plants	Aquatic Vertebrates	Terrestrial Herbivores	Terrestrial Omnivores	Terrestrial Carnivores
Ingestion or Uptake	●	○	●	○	○	●	●	●
Ingestion or Uptake	○	●	○	●	●	●	●	●
Ingestion or Uptake	○	●	○	●	●	○	●	○
Ingestion or Uptake	○	○	●	○	○	○	○	○

● Completed Pathway

○ Incomplete Pathway

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Figure 3-2
ECOLOGICAL CONCEPTUAL SITE MODEL
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

Huebner Rd

Union Pacific Railroad

LOW-WATER CROSSING

Threemile Creek

FORMER CONCRETE INCINERATOR PAD

FORMER BRICK AND MORTAR INCINERATOR

ACCESS ROAD

LEGEND

- RAILROAD
- FORMER FOUNDATIONS
- STREAM
- FLOW DIRECTION

NOTE:

THE EXACT LOCATION OF THE LOW-WATER CROSSING AND ACCESS ROAD WILL BE DETERMINED IN THE FIELD BASED ON ACCESSIBILITY, TOPOGRAPHY, AND VEGITAION.

0 60

SCALE IN FEET

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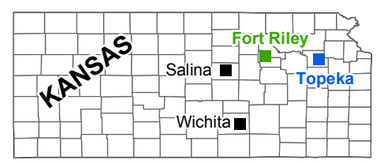

Not to Scale

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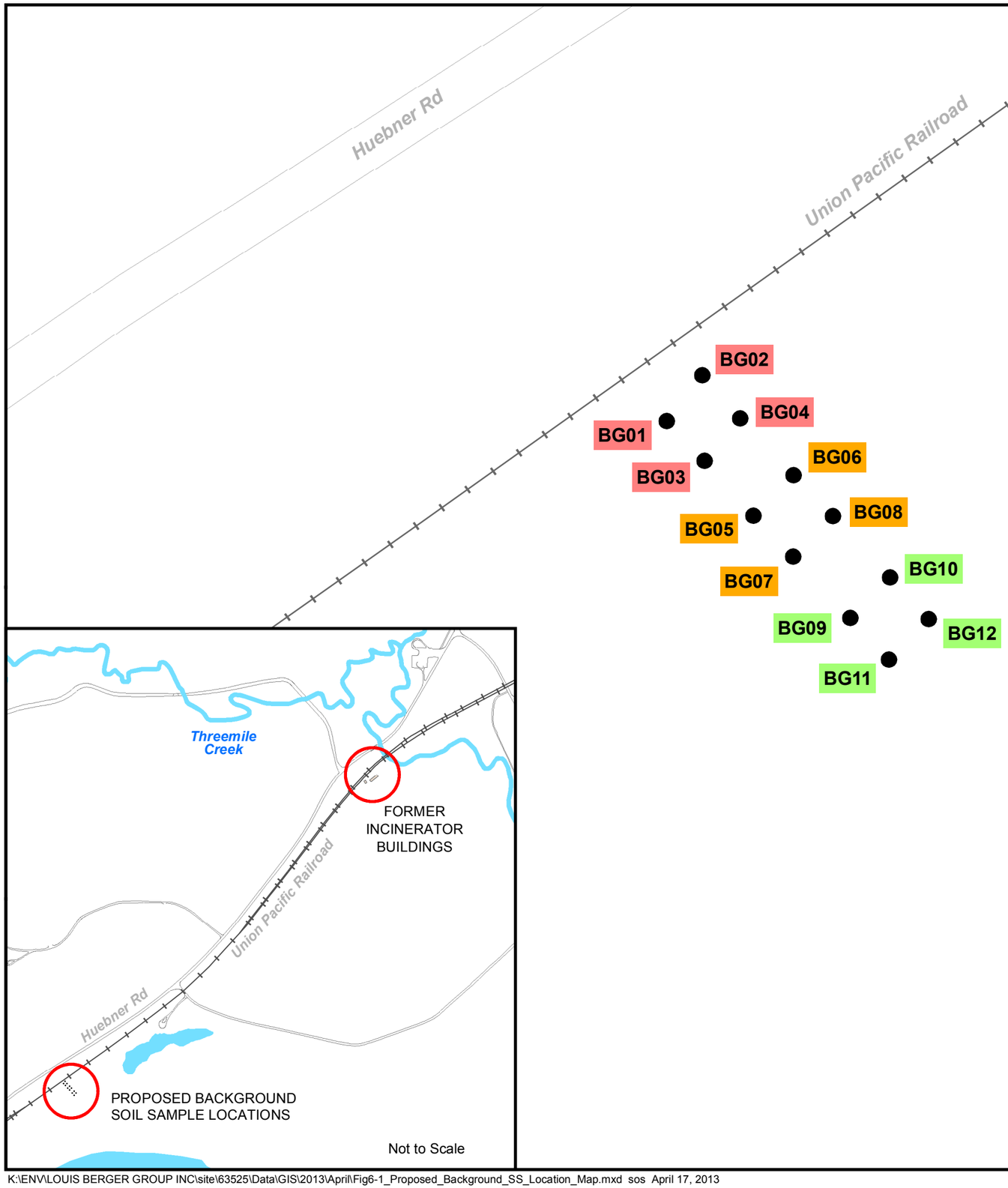
Figure 5-1

LOW-WATER CROSSING AND ACCESS ROAD LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

K:\ENV\LOUIS BERGER GROUP INC\site\63525\Data\GIS\2013\April\Fig5-1_Low_Water_Crossing_Access_Road_Map.mxd sos June 26, 2013



LEGEND

- BACKGROUND SOIL SAMPLE LOCATION
- BACKGROUND SAMPLES REPRESENTING UPLAND TERRACE
- BACKGROUND SAMPLES REPRESENTING FLOODPLAIN SLOPE
- BACKGROUND SAMPLES REPRESENTING KANSAS RIVER FLOODPLAIN
- RAILROAD
- FORMER FOUNDATIONS

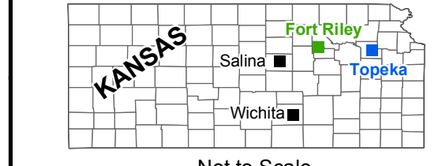
NOTE:

PROPOSED BACKGROUND SOIL SAMPLE LACATIONS MAY BE ADJUSTED BASED ON FIELD OBSERVATIONS & SITE TOPOGRAPHY. FOUR SAMPLE LOCATIONS WILL BE LOCATED IN EACH OF THE DEPOSITIONAL ENVIRONMENTS.

0 60

SCALE IN FEET

N



Not to Scale

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Figure 6-1

PROPOSED BACKGROUND SOIL SAMPLE LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

K:\ENV\LOUIS BERGER GROUP INC\site\63525\Data\GIS\2013\April\Fig6-1_Proposed_Background_SS_Location_Map.mxd sos April 17, 2013

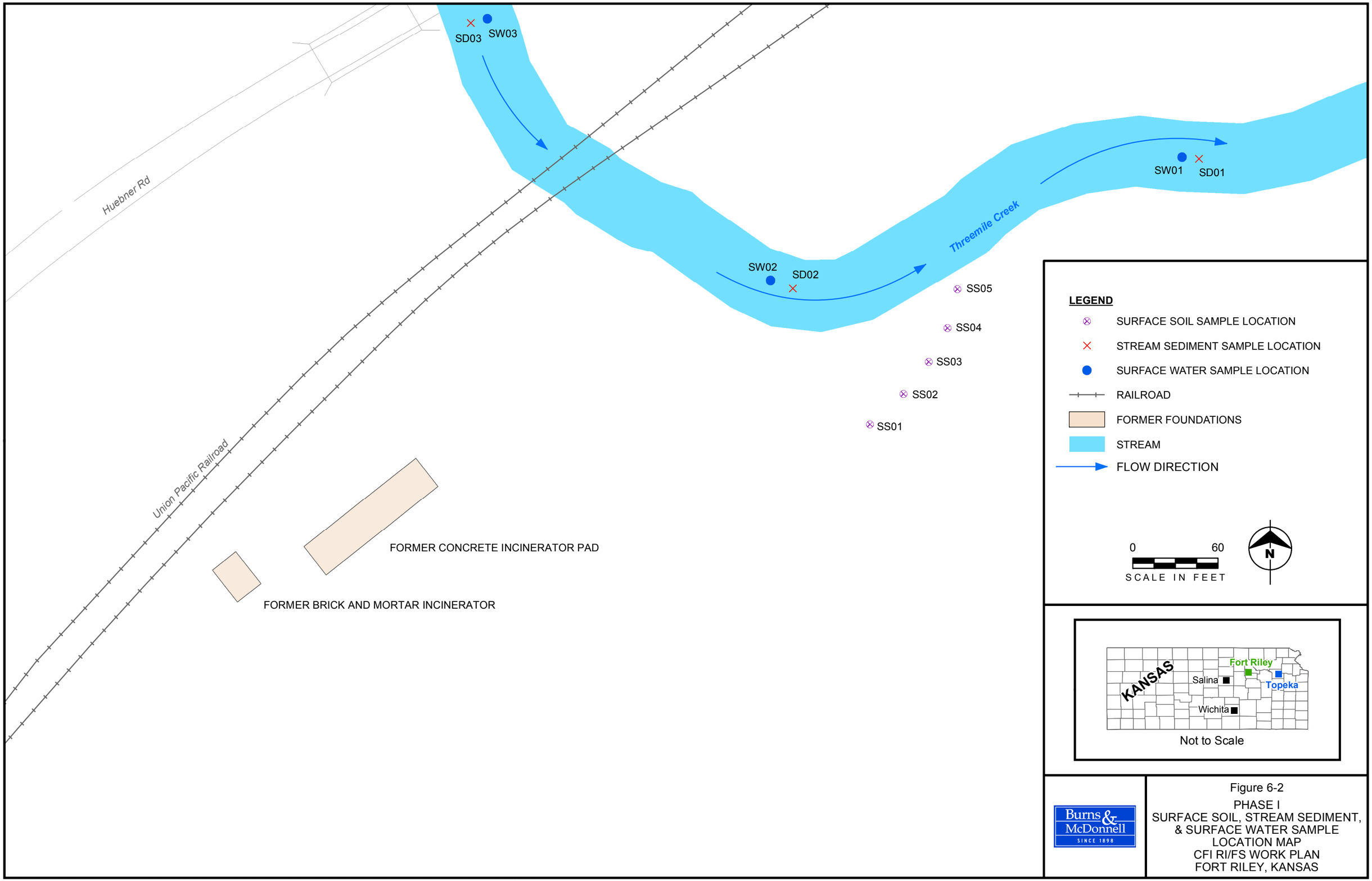
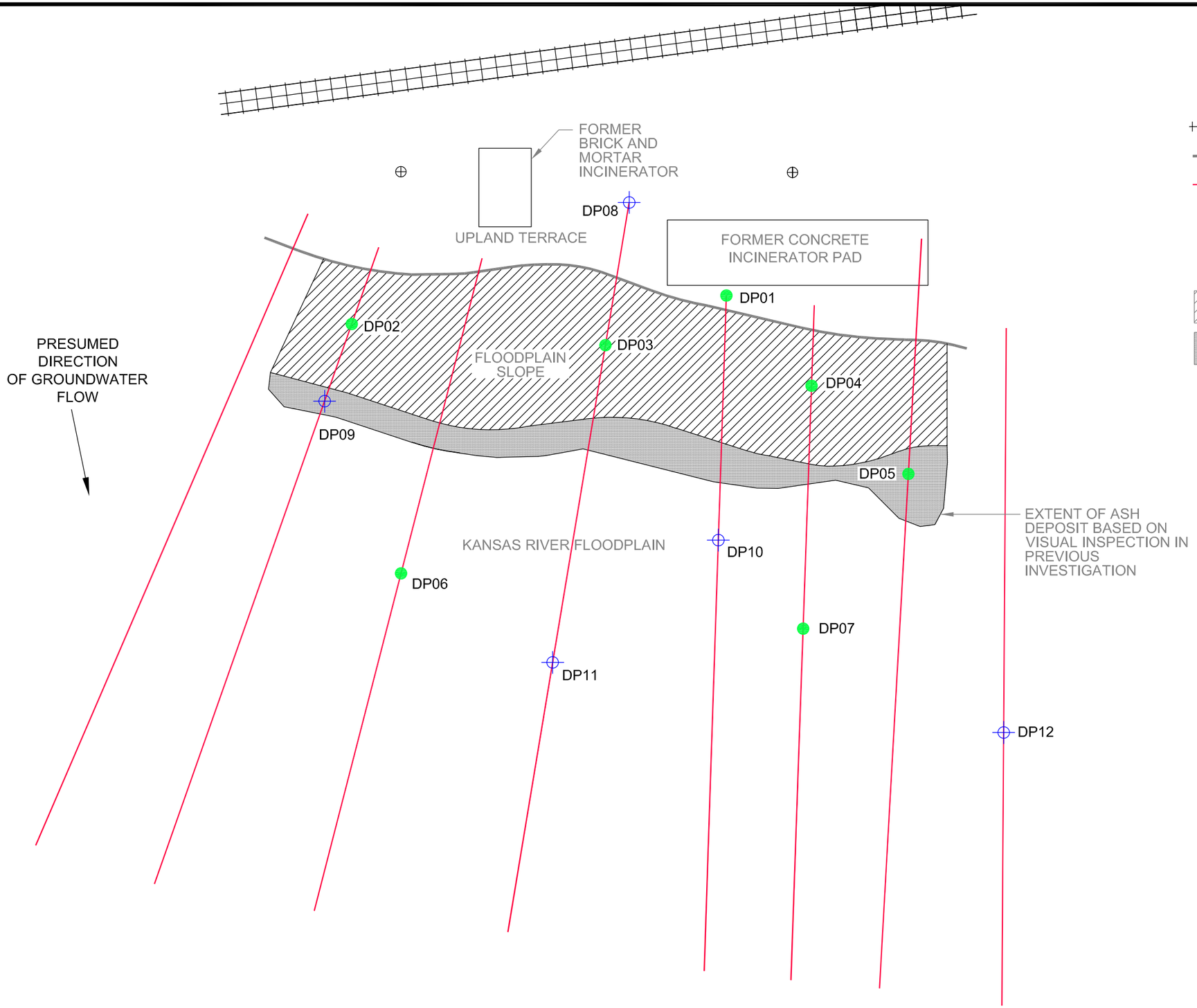


Figure 6-2

PHASE I
SURFACE SOIL, STREAM SEDIMENT, & SURFACE WATER SAMPLE LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

Burns & McDonnell
SINCE 1898

K:\ENV\LOUIS BERGER GROUP INC\site\63525\Data\GIS\2013\April\Fig6-2_PHASE_I_Surface_Sample_Location_Map.mxd sos April 17, 2013



LEGEND

- POWER POLE
- RAILROAD SIDING
- APPROXIMATE TOP OF SLOPE
- SAMPLE TRANSECT LINES
- PROPOSED PHASE I SOIL SAMPLE LOCATION
- PROPOSED PHASE I GROUNDWATER SAMPLE LOCATION
- ASH DEPOSITS COVERED BY FLOODPLAIN SLOPE SOILS
- ASH DEPOSITS COVERED BY FLOODPLAIN SOILS

N

0 20' 40' 80'

SCALE IN FEET

Figure 6-3

PHASE I DIRECT-PUSH SOIL AND GROUNDWATER SAMPLE LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

Burns & McDonnell SINCE 1898

COPYRIGHT © 2013 BURNS & McDONNELL ENGINEERING COMPANY, INC.

K:\ENV\LOUIS BERGER GROUP INC\SITE\63525\DATA\GIS\2013\APRIL\FIG6-3_PHASEI_DIRECTPUSH_GW_FTRILEY_KS.DWG 4/17/2013 4:53 PM CBANKS (osheldon)

SKEET RANGE

Threemile Creek

SS06

SS07

SS08

SW06

SD06

SW05

SD05

SW04

SD04

Unnamed Stream

Williston Point Rd

Huebner Rd

Union Pacific Railroad

Threemile Creek

CAMP WHITSIDE

FORMER CONCRETE INCINERATOR PAD

FORMER BRICK AND MORTAR INCINERATOR

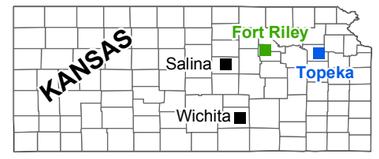
LEGEND

- SURFACE SOIL SAMPLE LOCATION
- STREAM SEDIMENT SAMPLE LOCATION
- SURFACE WATER SAMPLE LOCATION
- RAILROAD
- SKEET RANGE
- FORMER FOUNDATIONS
- STREAM
- FLOW DIRECTION

0 250 500

SCALE IN FEET

N



Not to Scale

Figure 6-4

PHASE II
SURFACE SOIL, STREAM SEDIMENT, & SURFACE WATER SAMPLE LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

Burns & McDonnell SINCE 1898

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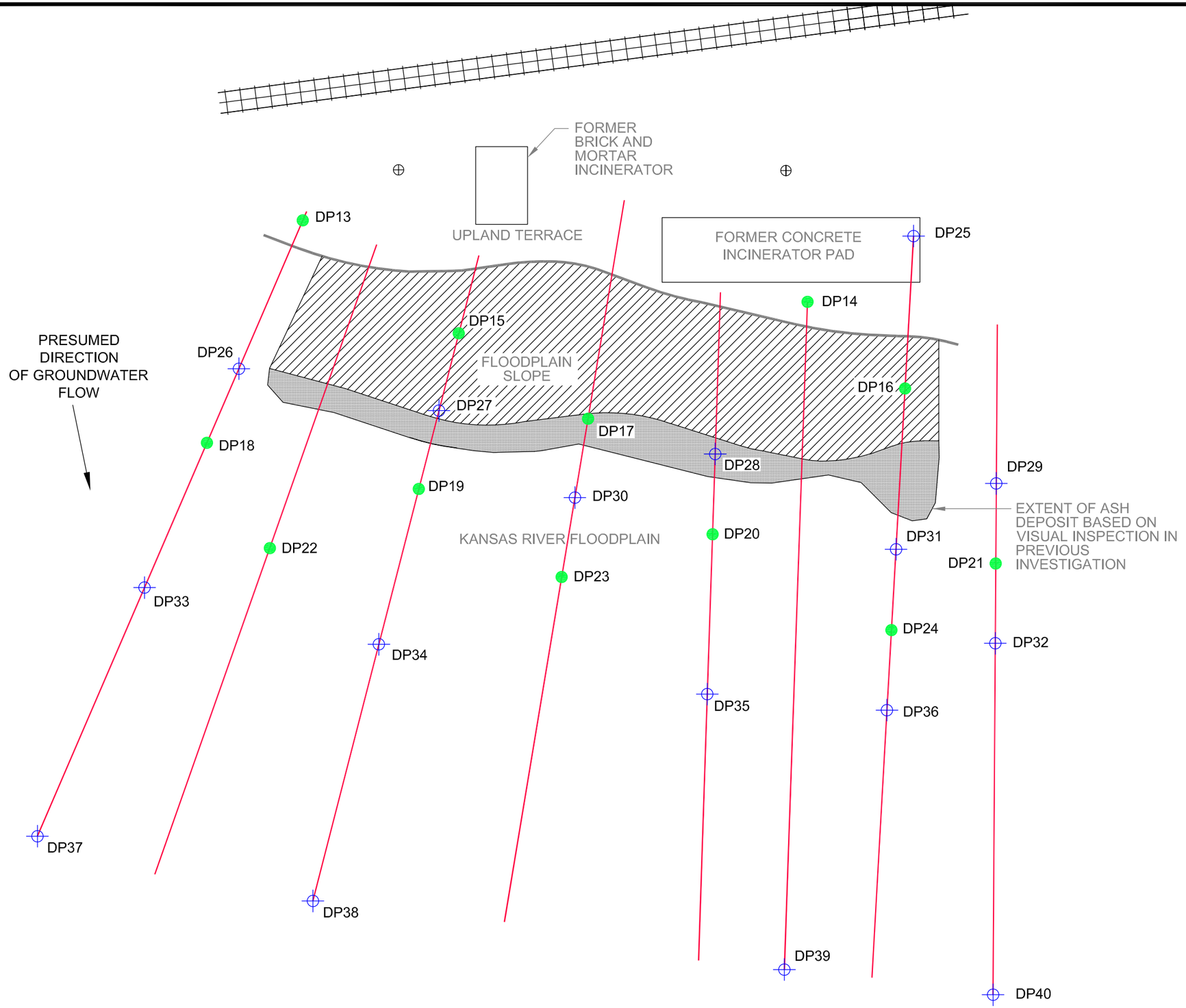


LEGEND

- POWER POLE
- RAILROAD SIDING
- APPROXIMATE TOP OF SLOPE
- SAMPLE TRANSECT LINES
- PROPOSED PHASE II SOIL SAMPLE LOCATION
- PROPOSED PHASE II GROUNDWATER SAMPLE LOCATION
- ASH DEPOSITS COVERED BY FLOODPLAIN SLOPE SOILS
- ASH DEPOSITS COVERED BY FLOODPLAIN SOILS

N

0 20' 40' 80'

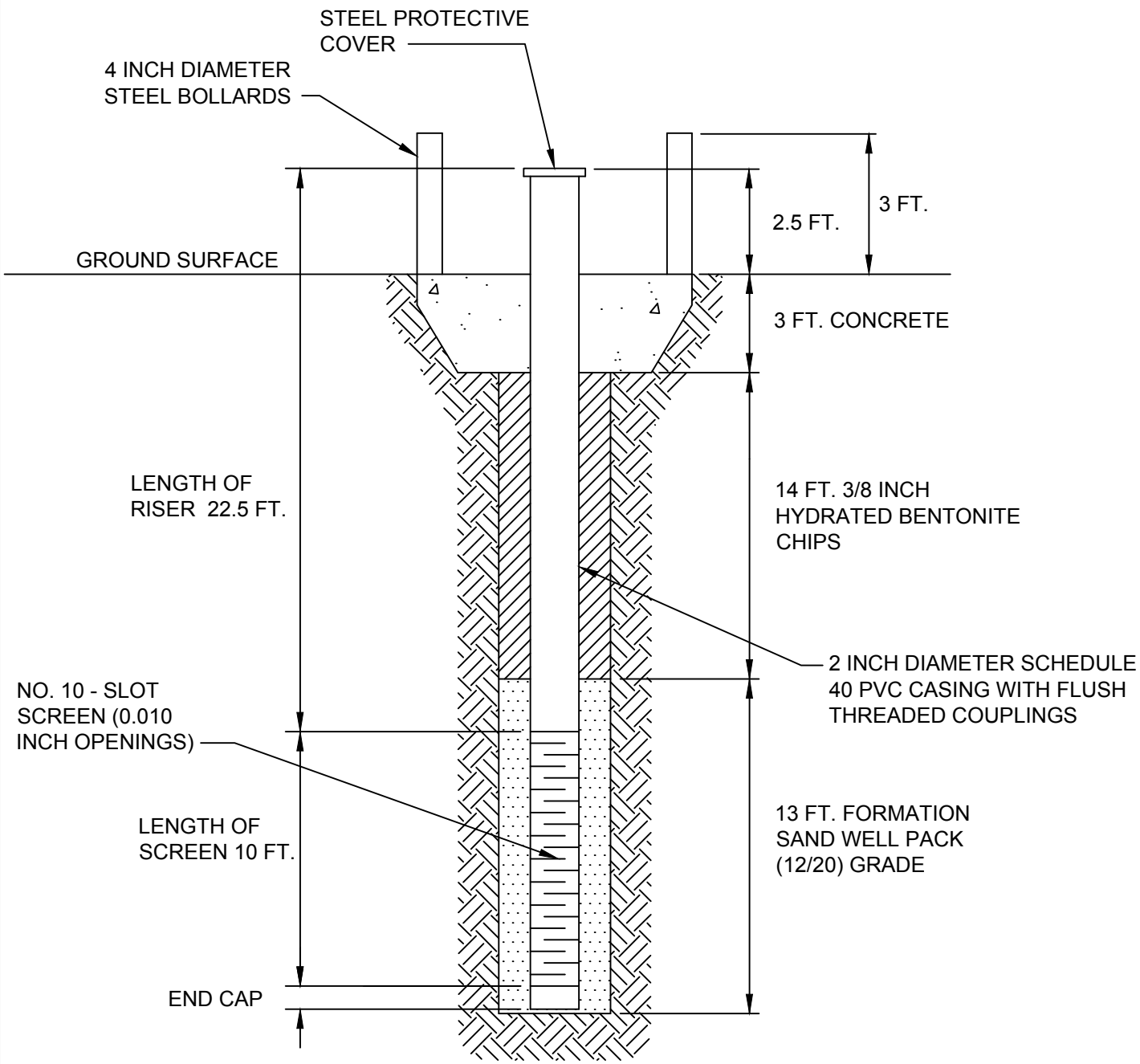
SCALE IN FEET

Figure 6-5

PHASE II DIRECT-PUSH SOIL AND GROUNDWATER SAMPLE LOCATION MAP
CFI RI/FS WORK PLAN
FORT RILEY, KANSAS

COPYRIGHT © 2013 BURNS & McDONNELL ENGINEERING COMPANY, INC.

K:\ENV\LOUIS BERGER GROUP INC\SITE\63525\DATA\GIS\2013\APRIL\FIG6-5_PHASEII_DIRECTPUSH_GW_FTRILEY_KS.DWG 5/7/2013 2:50 PM CBANKS (osheldon)



NOT TO SCALE

Figure 6-6
TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM
CFI RI/FS WP
FORT RILEY, KANSAS

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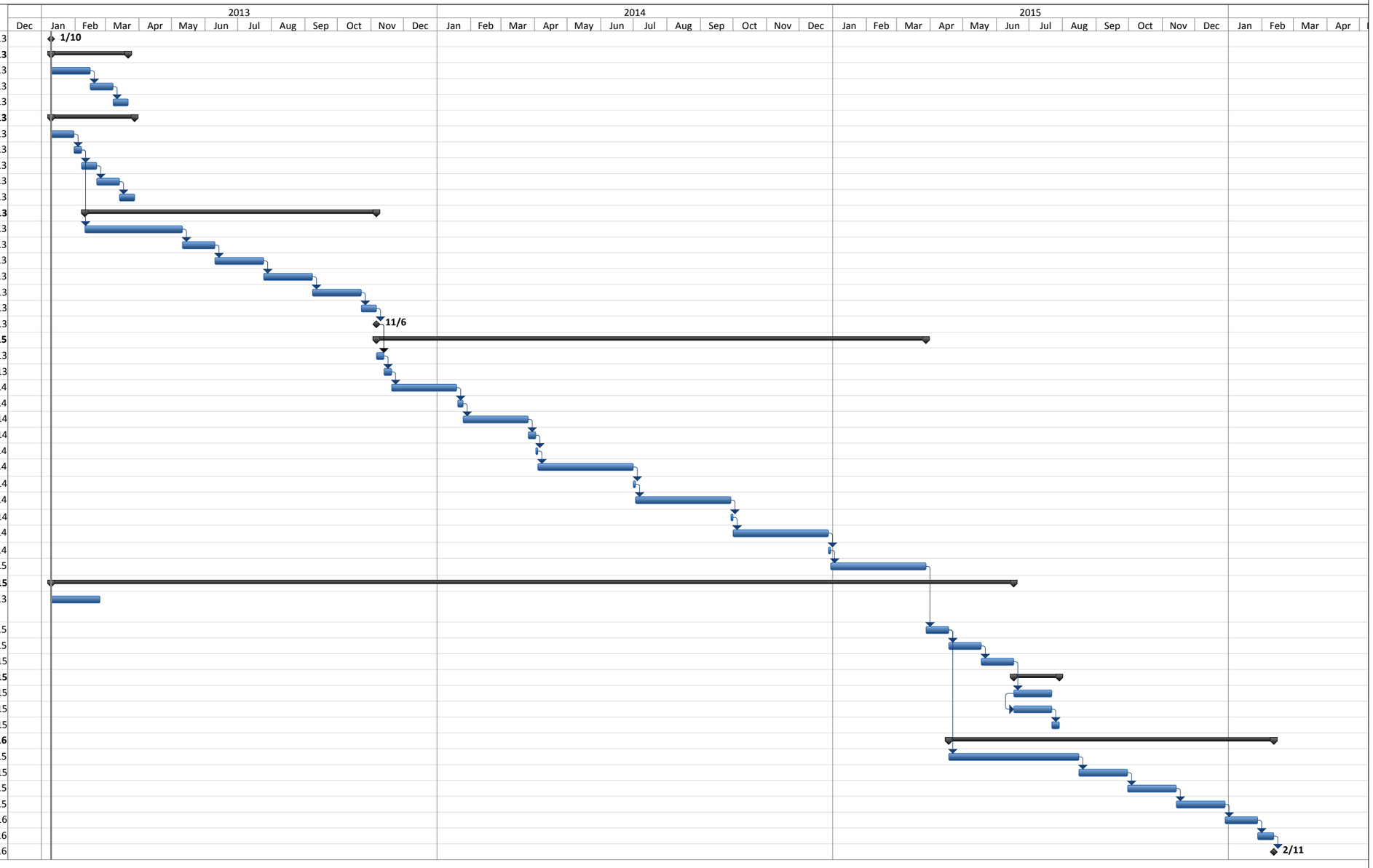
Figure 7-1
Project Schedule
CFI RI/FS Work Plan
Fort Riley, Kansas

ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Thu 1/10/13	Thu 1/10/13
2	**CQCP**	**51 days**	**Thu 1/10/13**	**Fri 3/22/13**
3	Draft	36 edays	Thu 1/10/13	Fri 2/15/13
4	Army Review	21 edays	Fri 2/15/13	Fri 3/8/13
5	Final	14 edays	Fri 3/8/13	Fri 3/22/13
6	**Technical Memo**	**55 days**	**Thu 1/10/13**	**Thu 3/28/13**
7	Working Draft	21 edays	Thu 1/10/13	Thu 1/31/13
8	Army Review	7 edays	Thu 1/31/13	Thu 2/7/13
9	Draft	14 edays	Thu 2/7/13	Thu 2/21/13
10	Regulator Review	21 edays	Thu 2/21/13	Thu 3/14/13
11	Final	14 edays	Thu 3/14/13	Thu 3/28/13
12	**Work Plans**	**192 days**	**Sun 2/10/13**	**Wed 11/6/13**
13	Working Draft	90 edays	Sun 2/10/13	Sat 5/11/13
14	Army Review	30 edays	Sat 5/11/13	Mon 6/10/13
15	Draft	45 edays	Mon 6/10/13	Thu 7/25/13
16	Regulator Review	45 edays	Thu 7/25/13	Sun 9/8/13
17	Final	45 edays	Sun 9/8/13	Wed 10/23/13
18	Army Backcheck on Final	14 edays	Wed 10/23/13	Wed 11/6/13
19	Final	0 days	Wed 11/6/13	Wed 11/6/13
20	**Fieldwork**	**363 days**	**Wed 11/6/13**	**Fri 3/27/15**
21	Site Preparation	7 edays	Wed 11/6/13	Wed 11/13/13
22	Phase I Sampling	5 days	Wed 11/13/13	Tue 11/19/13
23	Evaluation of Phase I Data	60 edays	Tue 11/19/13	Sat 1/18/14
24	Phase II Sampling	5 days	Mon 1/20/14	Fri 1/24/14
25	Evaluation of Phase I Data	60 edays	Fri 1/24/14	Tue 3/25/14
26	Inst and Dvlp 4 MWs	5 days	Wed 3/26/14	Tue 4/1/14
27	GW Sampling 1 - Field Collection	2 edays	Tue 4/1/14	Thu 4/3/14
28	GW Sampling 1 - Data Evaluation	88 edays	Thu 4/3/14	Mon 6/30/14
29	GW Sampling 2 - Field Collection	2 edays	Mon 6/30/14	Wed 7/2/14
30	GW Sampling 2 - Data Evaluation	88 edays	Wed 7/2/14	Sun 9/28/14
31	GW Sampling 3 - Field Collection	2 edays	Sun 9/28/14	Tue 9/30/14
32	GW Sampling 3 - Data Evaluation	88 edays	Tue 9/30/14	Sat 12/27/14
33	GW Sampling 4 - Field Collection	2 edays	Sat 12/27/14	Mon 12/29/14
34	GW Sampling 4 - Data Evaluation	88 edays	Mon 12/29/14	Fri 3/27/15
35	**Data Evaluation/Fate & Transport**	**634 days**	**Thu 1/10/13**	**Tue 6/16/15**
36	Preliminary Exposure Pathway Analysis Rpt	45 edays	Thu 1/10/13	Sun 2/24/13
37	Data Evaluation	21 edays	Fri 3/27/15	Fri 4/17/15
38	Fate and Transport Analysis	30 edays	Fri 4/17/15	Sun 5/17/15
39	Pathway Analysis Report	30 edays	Sun 5/17/15	Tue 6/16/15
40	**Baseline Risk Assessment**	**30 days**	**Tue 6/16/15**	**Tue 7/28/15**
41	Human Health Assessment	35 edays	Tue 6/16/15	Tue 7/21/15
42	Environmental Assessment	35 edays	Tue 6/16/15	Tue 7/21/15
43	Risk Summary and PRGs	7 edays	Tue 7/21/15	Tue 7/28/15
44	**RI Report**	**214 days**	**Fri 4/17/15**	**Thu 2/11/16**
45	Working Draft	120 edays	Fri 4/17/15	Sat 8/15/15
46	Army Review	45 edays	Sat 8/15/15	Tue 9/29/15
47	Draft	45 edays	Tue 9/29/15	Fri 11/13/15
48	Regulator Review	45 edays	Fri 11/13/15	Mon 12/28/15
49	Final	30 edays	Mon 12/28/15	Wed 1/27/16
50	Army Backcheck on Final	15 edays	Wed 1/27/16	Thu 2/11/16
51	Final Submittal	0 days	Thu 2/11/16	Thu 2/11/16



Project: CFI schedule
Date: Fri 7/12/13

Task Milestone Summary

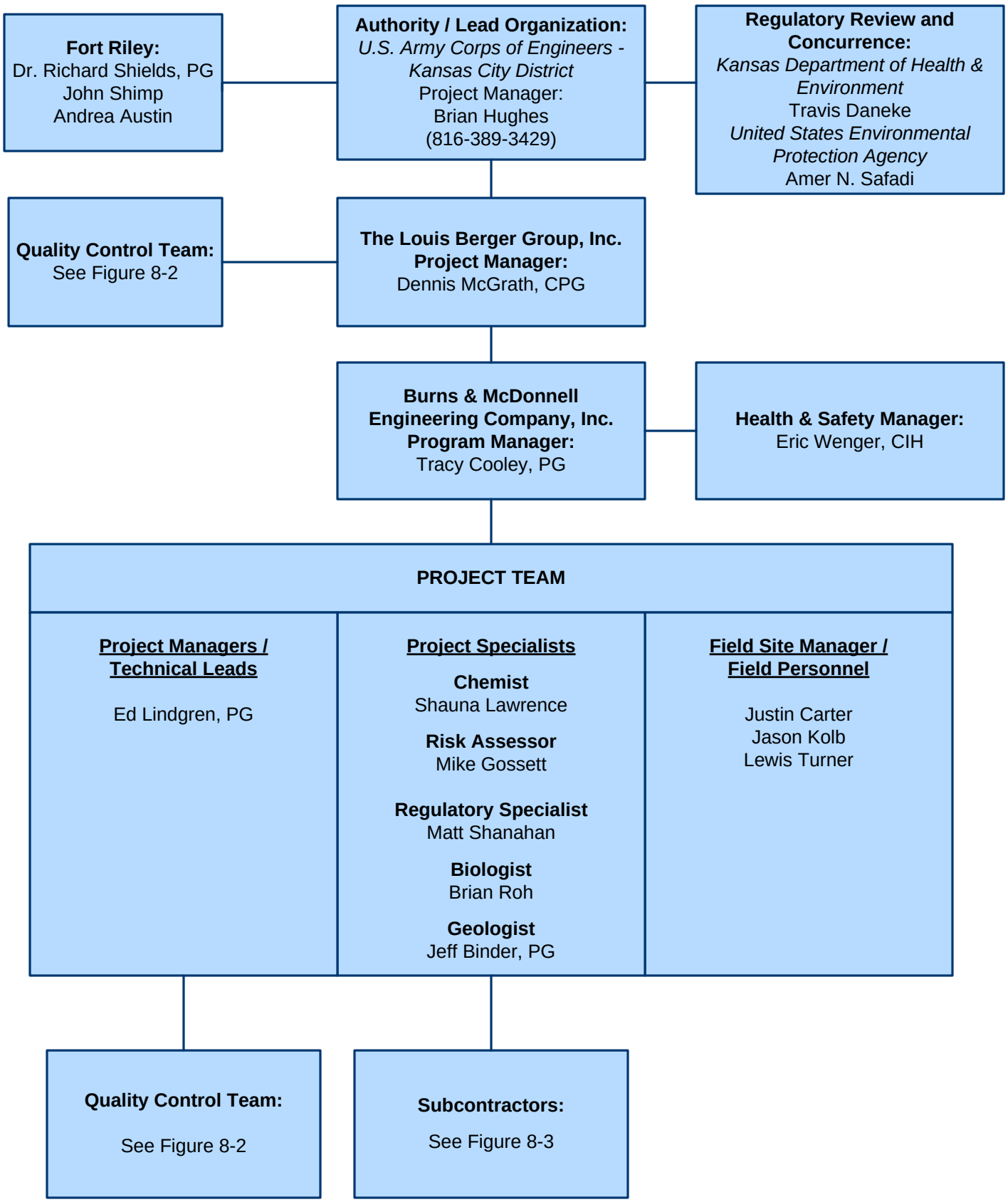


Figure 8-1
PROJECT ORGANIZATIONAL CHART
CFI RI/FS Work Plan
Fort Riley, Kansas

Avatar\69765

Quality Control Team		
Name	**Technical Specialty**	**Years of Experience**
Martha Hildebrandt, PG (BMcD)	Quality Control Manager	24
Sharon Shelton (BMcD)	Technical Specialty Chemist	19
Diana Marquez (BMcD)	Risk Assessor	21
Greg Gorman (BMcD)	Regulatory Specialist	26
Joseph Werner (BMcD)	Biologist	39
Dennis Moser, PG (BMcD)	Geologist	21
Rudy Leutzinger, CIH, CSP, CHMM (BMcD)	Certified Industrial Hygienist	27
Kenneth Goldstein, CGWP (LBG)	Groundwater	32
Dr. Richard Califano (LBG)	Risk Assessor	27
Dennis McGrath, CPG (LBG)	Environmental Investigations/ Reporting	39

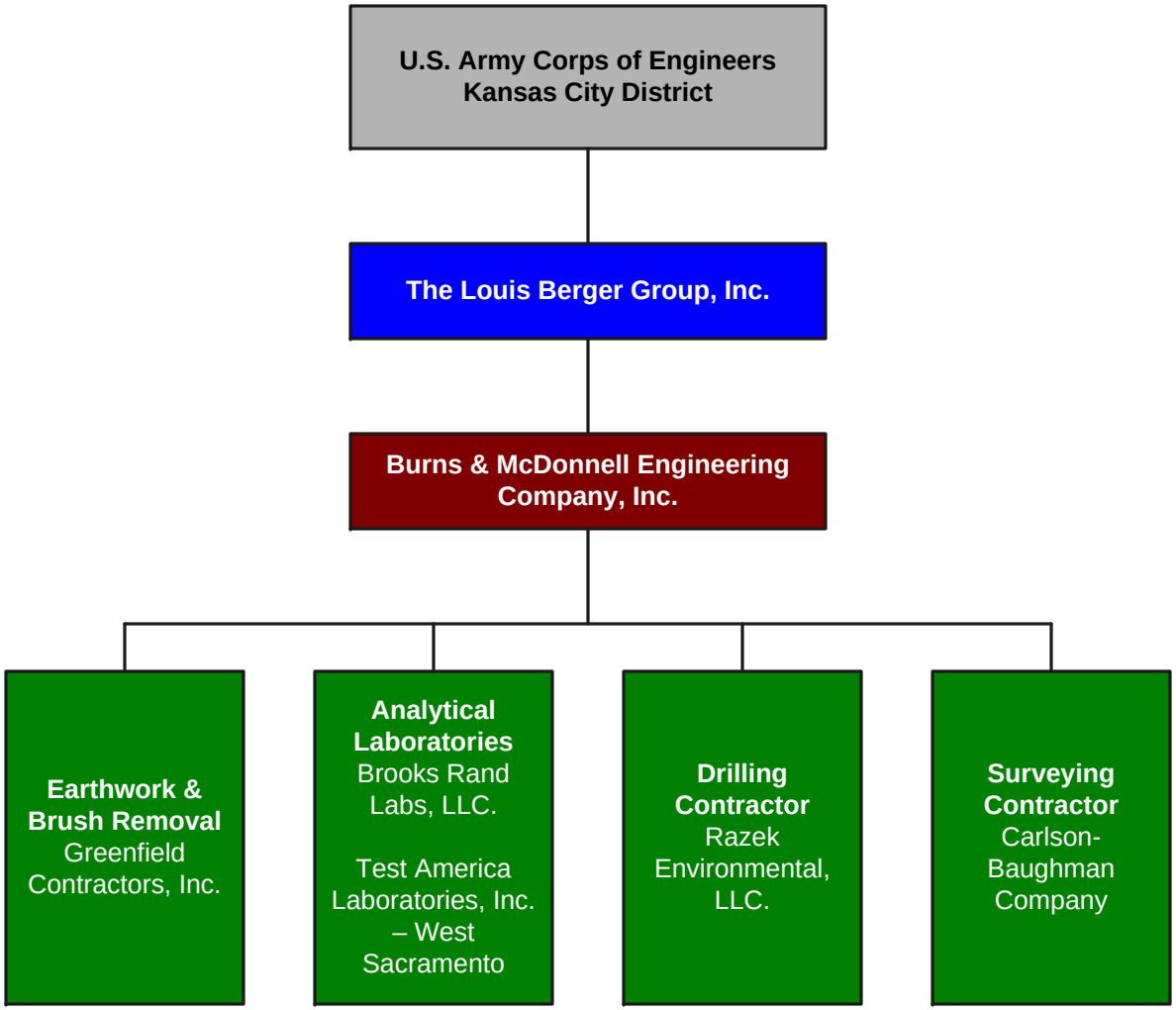
Notes:

BMcD – Burns & McDonnell Engineering Company, Inc.
LBG – The Louis Berger Group, Inc.

Burns & McDonnell SINCE 1898

Figure 8-2
QUALITY CONTROL TEAM
CFI RI/FS Work Plan
Fort Riley, Kansas

Avatar\69765



Legend

- LBG Personnel
- BMcD Personnel
- Subcontractors

Burns & McDonnell SINCE 1898

Figure 8-3
Subcontractors
CFI RI/FS Work Plan
Fort Riley, Kansas

APPENDIX A

Historical Environmental Investigations (Provided on CD)

- **2000 Arrowhead Contracting, Inc. Investigation**
- **2006 USACE-CENWK Investigation**
- **2010 CTI & Associates Investigation**

2000 Arrowhead Contracting, Inc. Investigation

DRAFT
PROJECT REPORT

FIELD INVESTIGATION
FORMER INCINERATOR SITE
FT. RILEY, KANSAS

CONTRACT NO. DAKF19-01-P0091
SOLICITATION NO. DADF19-01-T0022

Submitted to:

Directorate of Environmental Safety
Ft. Riley
Building 407
Pershing Court
Ft. Riley, Kansas 66442

Submitted by:

Arrowhead Contracting, Incorporated
12920 Metcalf, Suite 150
Overland Park, Kansas 66213

April 13, 2001

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B	Sample Collection Field Sheets

1.0 Introduction

This document constitutes for the project report for the field investigation of the former WWI-era incinerator site at Fort Riley, Kansas. Arrowhead Contracting, Inc. of Overland Park, Kansas conducted the work in March and April of 2000 pursuant to the requirements of Contract DAKF19-01-P0091 and under the direction of the Ft. Riley Directorate of Environmental Safety (DES). The purpose of this report is to describe the field and analytical procedures used during the project and present the results and findings of the investigation.

WWI-era mapping indicates that an incinerator was formerly located immediately south of present Huebner Road and rail road tracks and west of Threemile Creek. Foundation and slab remnants were identified at the site. Based on observation of concrete remnants in the field and depiction of the footprint of the incinerator foundation on historical maps, it is estimated that former foundation covered an area of 10,750 ft^2 (refer to Figure 1-1) with a maximum length and width of 200 feet and 70 feet, respectively. The investigation was performed because the site could potentially contain heavy metals contamination in shallow soil as a result of historic operation of an incinerator by the military. The results of this field investigation will support Fort Riley's assessment of the environmental impact at the site.

The remainder of this report consists of five sections. Section 2.0 presents a discussion of the field activities and methods associated with the collection of soil samples. Section 3.0 presents a discussion of analytical activities and methods, including x-ray fluorescence (XRF) field screening and off-site confirmatory analysis of soil samples. Section 4.0 presents a discussion of the results and findings of the field investigation. A list of applicable references is presented in Section 5.0. In addition to the various tables and figures included with this report, two appendices are provided. Appendix A contains all of the XRF and laboratory data (including QA/QC). Appendix B contains the sample collection field sheets for soil samples.

2.0 Soil Sampling Activities

This section discusses the general sampling approach, the methods used for soil sampling, the sample labeling protocol, and field documentation and quality control procedures.

2.1 Sampling Locations, Approach, and Quantities

The sampling program included the collection of composite soil samples from 30 distinct locations identified as INC01 through INC30 (refer to Figure 1-1). The locations were selected randomly in the field to adequately cover the area interest. The rationale/approach for each group of sample locations is summarized by the following table.

INC01 - INC04, and INC28	Characterize soils within the limits of former foundation.
INC05, INC07 and INC10 – INC14	Characterize soils adjacent to the perimeter of former foundation.
INC06, INC08, INC09, and INC27	Characterize soils immediately upgradient of site.
INC10 and INC29	Characterize soils west of site.
INC25, INC26, and INC30	Characterize soils east of site.
INC15 – INC18	Characterize soils immediately downgradient of site.
INC19 – INC24	Characterize soils downgradient of site.

At each location, samples were collected from 0 in. to 6 in. below ground surface (bgs). At 22 of the 30 locations, samples were collected from 6 in. to 12 in. bgs. Samplers were unable to obtain a sample from 6 in. to 12 in. bgs at eight locations due to the presence of concrete or rock below the soil. At 6 locations (20% of the total number of locations), a third sample was collected from the depth interval 12 in. to 24 in. bgs. In total, 58 samples were collected from the 30 sample locations.

2.2 Sample Collection Methods

Sampling personnel staked out the locations on the morning of March 23. Locations were selected to provide areal coverage of the site in accordance with approach outlined in Section 2.1. The sampling team also collected the samples on March 23, 2001. Following sample collection, the locations were measured relative to the presumed corners of the former foundation based on the position of concrete slab remnants.

In general, sample collection was performed in accordance with the Field Sampling Plan and amendment (Arrowhead, 2001). At each location, soil samples were composited from five sample points (aliquots). Sample aliquots were identified by centering a pre-fabricated, wooden grid over the sample location. Discrete soil samples were then collected from each interval (0 in. to 6 in. bgs, 6 in. to 12 in. bgs, and, as necessary, 12 in. to 24 in. bgs) using a stainless-steel, small barrel drive sampler. Soil from each aliquot was composited by thoroughly mixing in a stainless steel bowl with a stainless steel spoon. All vegetation, debris, and particles exceeding 2 mm were removed and returned to the sample boring location. The soil was then placed into a quart-size, plastic (Ziploc) bag and labeled to identify the location and depth interval (refer to Section 2.3). The soil within the plastic bag was kneaded by hand to facilitate homogenization. To prevent cross-contamination, the sampling equipment was decontaminated between each sampling location and between the 6 in. to 12 in. bgs and 12 in. to 24 in. bgs depth intervals. Decontamination consisted of rinsing the equipment with clean water and scrubbing with phosphate-free soap, followed by rinsing with de-ionized water. After collection, samples were delivered to an on-site field laboratory for XRF analysis (refer to Section 3.1).

2.3 Sample Labeling and Identification

Soil samples were labeled with the sample ID, date, and time. Sample IDs consisted of a prefix corresponding to the location ID (e.g. INC08, INC24) followed by four digits representing the depth interval:

- "0006" – ground surface to 6 in. bgs
- "0612" – 6 in. to 12 in. bgs
- "1224" – 12 in. to 24 in. bgs

For example, the sample ID "INC230612" represented the sample from the 6 in. to 12 in. bgs depth interval from location INC23.

2.4 Field Documentation and Quality Control

The Site Supervisor and Field Team Leaders maintained a field logbook that documented the field and analytical activities and other pertinent information. The field logbooks were submitted to Ft. Riley DES at the conclusion of the project. In addition to the field logbooks, sampling technicians completed sample collection field sheets. The sample collection field sheets for this site are included in Appendix B.

The Site Supervisor completed a daily quality control (QC) inspection which was documented on a Daily QC Checklist. The Site Supervisor also completed a Daily Quality Control Report (DQCR). This report presented a summary of the day's field and analytical production, including XRF field screening results. The DQCR and QC checklist were previously submitted to the Ft. Riley DES project manager; thus, they are not provided with this document.

3.0 Field Screening and Analysis Activities

This section discusses the XRF field screening procedure, QA/QC field screening procedures, method detection limits, and confirmatory sampling and analysis.

3.1 Field Screening Methods

Samples collected during the project were screened/analyzed for the following heavy metals using a field-portable XRF spectrometer (Spectrace Model 9000 with a Model 9290 probe manufactured by Thermo MeasureTech of Round Rock, Texas):

- Barium
- Copper
- Lead
- Tin
- Zinc

The XRF bench-scale system consisted of the electronic unit (with software), instrument probe, lab stand, sample shield, and power and computer cords. Samples for this site were analyzed on April 2, 2001.

XRF field screening was performed in accordance with the Field Sampling Plan and amendment (Arrowhead, 2001), referencing SW-846 Method 6200 (EPA, 1998) and Thermo MeasureTech instructions and operating procedures (Thermo MeasureTech, 1994). At the beginning of the day, the FPXRF spectrometer was turned on and allowed to warm up for at least 10 minutes. After warming up, initial quality control checks (refer to Section 3.2) were performed. Soil samples were then prepared for analysis as follows:

- A small portion of soil was removed from the plastic bag collected in the field.
- The soil was wrapped in aluminum foil and dried in an oven for 2 – 4 hours at less than 150 °C.
- Following drying, the sample was further homogenized by grinding/pulverizing using a mortar and pestle to the extent the soil would pass through a 10-mesh sieve.
- Approximately 20 grams of the pulverized soil was placed in a 31-mm polyethylene sample cup. The remaining ground soil was placed in a plastic container, labeled, and retained for possible off-site confirmatory analysis (refer to Section 3.4).

- The sample cup was then be covered with Mylar x-ray film and secured with a polyethylene locking ring.

Following preparation, the polyethylene cup containing the soil was placed within the sample ring above the instrument probe aperture. The sample shield was then placed over the sample cup, and the sample analyzed. (Refer to Section 3.3 for a discussion of the total "counting time" required to analyze the sample.) After analysis was complete, the sample ID was entered into the Spectrace 9000, and the result (concentration and standard deviation) for each metal was manually recorded in the field logbook. The results were saved by the Spectrace 9000 computer, and were eventually downloaded to a personal computer in text (.txt) format. Following analysis, all equipment (sample cup, mortar, etc.) was thoroughly cleaned to prevent cross contamination. The soil from the sample cup was poured into the plastic container along with the corresponding pulverized soil that was retained for possible off-site confirmatory analysis.

3.2 Field Screening QA/QC

In accordance with the Field Sampling Plan and amendment (Arrowhead, 2001), the following quality assurance/quality control (QA/QC) checks were performed:

- Energy calibration (resolution) checks
- Instrument blanks
- Calibration verification (standard) checks
- Method blanks
- Precision checks

Table 3-1 presents a summary of each QA/QC check, including the frequency, rationale, and corrective actions. In addition to these QA/QC checks, the overall QA/QC program included analysis of confirmatory samples by an off-site laboratory to verify the comparability of XRF field screening results (refer to Section 3.4).

3.3 Field Screening Detection Limits

For XRF analysis, method detection limits are a function of the "counting time" – the amount of time each radioactive source within the instrument probe irradiates the sample. In general, increasing the source's counting time (up to a point) decreases the detection limit for the

elements detected by that source. The counting times are adjustable depending on the required detection limits and other data objectives.

The method detection limits were determined as described in SW-846 Method 6200 (EPA, 1998). According to Method 6200 Section 9.6, the results of replicate analyses of the low-concentration NIST standard can be used to calculate average site-specific method detection limits. The method detection limit is defined as three times the standard deviation (SD) of the results for the low concentration NIST sample.

At the beginning of the project, the low-concentration NIST standard (No. 2709) was analyzed to determine the initial detection limits and source counting times. The NIST sample was analyzed several times in replicate at various source counting times. This process was repeated iteratively until optimal detection limits and counting times were achieved. The estimated project-specific detection limits for the five required heavy metals are presented in Table 3-2. It should be noted that the NIST 2709 sample did not contain tin. Therefore, the detection limit for tin is estimated based on the results for site samples with low concentrations of tin.

According to Method 6200 Section 9.6, the SD-based detection limit criteria can be used to determine the usability of a particular result. A result greater than the average calculated detection limit (refer to Table 3-2), but less than three times the SD associated with the result, should not be used as a quantitative measurement. Conversely, a result is below the average calculated detection limit, but greater than three times the associated SD, should be coded as an estimated value. For this reason, project XRF results are reported as the measurement concentration (PPM) combined with the SD.

3.4 Confirmatory Sampling and Analysis

As part of the overall QA/QC program, 25 percent of all samples collected were submitted to an off-site laboratory for confirmatory analysis of the following metals:

Cd & Am sources would have covered these

element 16-92 can be w/ At # detected & quantified

- Antimony
- Arsenic
- Copper –
- Lead –
- Mercury
- Zinc –

why these versus the list on Pg 3-1?
Seems worthless to do w/o field values to correlate

Off-site analytical services were provided by Continental Analytical Services, Inc. of Salina, Kansas. Samples were analyzed per SW-846 Method 6010B for antimony, arsenic, copper, lead and zinc and SW-846 Method 7471A for mercury.

Confirmatory samples were selected by the Field Supervisor to represent a range of lead concentrations and to provide spatial coverage of the site. Off-site laboratory QA/QC was verified through the collection and analysis of duplicate samples. Duplicate samples were collected at a frequency of 10% of the confirmatory samples. For the project, a total of 15 confirmatory samples and 2 confirmatory duplicate samples were collected and analyzed.

Confirmatory samples were collected/prepared at the on-site laboratory following XRF field screening. Each sample was taken from the pulverized soil that that was previously prepared for XRF field screening (refer to Section 3.1). Soil was placed in a 25-ml glass jar provided by the off-site laboratory, and the jar was filled to at least 33 percent capacity. The sample was then labeled as described in Section 2.3 plus "-L" or "-LD" at the end of the ID to denote a laboratory sample or laboratory duplicate, respectively. The samples were then packed in a cooler for shipment to the off-site laboratory. Chain-of-custody records were completed and placed in the cooler. The cooler was sealed and taped, and a custody seal was applied. The samples were shipped by FedEx to the off-site laboratory.

delete

4.0 Field Investigation Results and Findings

This section presents the results of the field investigation, including a summary of XRF field screening, an assessment of the QA/QC performance of the XRF field screening process, an evaluation of the correlation between XRF results and confirmatory results, and a summary of laboratory analytical results. The data and findings/interpretations provided in the following sections are based on assessment of project results (XRF and confirmatory). For the purpose of data interpretation:

- "Elevated" results are defined as concentrations greater than the Kansas KSK Residential level for metals in soil (the assumed action levels).
- Lead is believed to be the governing contaminant at the site – i.e. the contaminant present at the highest concentration relative to the action level and for which any future actions (if necessary) would be initiated.

4.1 Field Screening Results

Table 4-1 provides a summary of the results of XRF field screening for metals at the site. Lead was detected at a concentration greater than 400 PPM in samples from INC10 and INC13, suggesting that lead may be present at elevated levels in soils immediately surrounding the former incinerator foundation.

4.2 Confirmatory Results

A summary of the laboratory analytical results for metals is presented in Table 4-2. Additionally, Figure 4-2 illustrates a comparison lead concentration to concentrations of arsenic, copper, and zinc in samples analyzed by the off-site laboratory. Overall, there appears to be a correlation between the lead concentration and the concentrations of other metals. High concentrations of arsenic, copper, and zinc are generally associated with high concentrations of lead; conversely, lower concentrations of lead are generally associated with lower concentrations of the other metals. The concentrations for copper appear to be the least correlated with lead. The following are additional generalized interpretations regarding the metals data:

- With a few exceptions (see below), arsenic, copper, zinc and mercury were not detected at levels significantly above the national ranges or averages for these metals in soil (refer to Table 4-2).

- Zinc, copper, and mercury concentrations in all samples were well below the Kansas RSK Residential levels.
- Arsenic was detected at a level slightly above Kansas RSK Residential criteria in samples from INC13, INC14, and INC15, indicating that arsenic may present at elevated levels on downgradient side of the former foundation. However, the concentrations were below the upper national range for arsenic in soil.
- The highest two detections for zinc (1,380 PPM and 1,040 PPM) were detected in the same samples as the highest two concentrations of arsenic - INC15006 and INC130006. The corresponding concentrations for lead were 170 PPM and 160 PPM, respectively.
- All antimony and the majority of mercury results were ND. Mercury results greater than ND were generally associated with higher results for other metals.

4.3 Field Screening QA/QC Assessment

The following table summarizes the results of QA/QC checks performed during XRF analysis (refer to Table 3-1).

Energy Calibration Checks - Number of Failed Checks	0
Analytical Background (Blank) Checks – Number of Failed Checks	0
Method Blanks – Number of Failed Checks	0
Precision Checks – Number of Failed Checks	0
Calibration Verification (Standard) Checks – Number of Failed Checks	0
Standard Checks – %D for Medium Concentration NIST Standard	-10.6% to +10.3%
Standard Check – %D for High Concentration NIST Standard	-2.7%
Precision Check – %RSD	7.7%

Per SW-846 Method 6200 (EPA, 1998), the acceptable %D is for a calibration verification (standard) check is +/-20%. The acceptable %RSD for a precision check is < 20%. Therefore, all calibration verification checks and the precision check were within the allowable limits. Based on successful calibration verification checks and energy calibration checks, it is apparent that the XRF system retained proper calibration thorough out the project. Precision check results indicate that the XRF system was able to reproduce a measurement for a standard of known

concentration. The success of analytical background checks and method blank analyses indicate that laboratory cross-contamination was adequately prevented and did not compromise the integrity of the XRF results.

4.4 Field Screening/Confirmatory Analysis Comparability

A summary of the comparability between XRF results and confirmatory results is provided by Table 4-3. The average %D for confirmatory results was –61%, -39%, and –13% for copper, lead, and zinc, respectively, indicating that the XRF results were typically higher than the corresponding confirmatory results. Of 45 confirmatory results (15 samples x 3 metals per sample), 28 results were within 50% of the corresponding XRF result. All confirmatory results (excluding the copper result for INC100006-L) were within 100% of the corresponding XRF result. A correlation coefficient (r^2) was also calculated for the data for each metal per SW-846 Method 6200. According to Section 9.7 of Method 6200 (EPA, 1998): "The correlation coefficient (r^2) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r^2 is 0.9 or greater ..., the data could potentially meet definitive level data criteria." The correlation coefficients for copper, lead, and zinc were calculated to be 0.82, 0.95, and 0.94, respectively. Thus the XRF results significantly exceed the criteria for screening level data. XRF results for lead and zinc meet the criteria for definitive data. Overall, the relatively good comparability between confirmatory results and XRF results suggests that the XRF process was reliable and that the XRF data is accurate and valid.

4.5 Field Observations

Prior sampling, the Site Supervisor conducted a reconnaissance of the site to determine the preliminary sample locations. During the site reconnaissance, an empty, rusted 55-gallon drum was observed approximately 50 southwest of the former incinerator foundation. No other significant observations were noted during the reconnaissance.

Additionally, during sample collection and XRF analysis, samples were visually assessed for the presence of residual ash or other waste-related materials. The following samples were noted as containing a small pieces of hardened, black, slag-like material: INC030006, INC080006, INC130006, INC140006, INC141224, and INC150006. The material was relatively porous and had some structure, but was not conclusively identified as ash.

5.0 References

Arrowhead Contracting, Inc. Draft-Final Sampling and Field Sampling Plan and Health and Safety Plan. March 2001.

Arrowhead Contracting, Inc. Quality Control Checks - Amendment to Field Sampling Plan and Health and Safety Plan. March 2001

Thermo MeasureTech. Spectrace 9000 Standard Operating Check – Soils Application. May 1994.

Thermo MeasureTech. Spectrace 9000 Portable XRF Analyzer. August 1994.

U.S. Environmental Protection Agency . SW-846 Method 6200 - *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment.* July 1998.

TABLES

Table 3-1. XRF Field Screening QA/QC Checks

QC Check	Purpose and Method of Performance	Frequency and Rationale	Corrective Action
Energy Calibration	To verify instrument resolution and check for instrument "drift" (i.e. shifting of x-ray lines). Performed by analyzing pure iron (Fe) sample and then checking to be sure the Fe spectrum peak is correctly positioned and has the correct intensity (in kiloelectron volts).	This check will be performed at the beginning of each day. A successful energy calibration check at the beginning of the day adequately confirms that (1) the instrument is operating properly and is ready for ensuring analyses and (2) the instrument was operating properly during the previous day. Energy calibration checks will also be performed randomly during analysis.	If an energy calibration check fails, then the results for samples analyzed between the failed check and the previous successful check will be deemed invalid. The corresponding samples will be re-analyzed upon making the appropriate adjustments to the instrument
Calibration Verification	To verify the ability of the instrument to accurately quantify analytes of interest. Performed by analyzing standards with known (certified) concentrations of target analytes and calculating percent difference (%D) from the certified values.	The calibration verification check will be performed using National Institute of Standards & Technology (NIST) standards. The check will be performed in accordance with Method 6200: at the beginning and end of each day and during analysis.	If the calibration verification check fails, then the results for samples analyzed between the failed check and the previous successful check will be deemed invalid. The corresponding samples will be re-analyzed upon making the appropriate adjustments to the instrument.
Instrument Blank	To verify that contamination is not being spread to the instrument probe. Performed by analyzing a quartz block.	The instrument blank check will be performed using the quartz block during analysis (random frequency) and at the end of the day. A successful instrument blank check at the end of the day confirms that the probe is clean and ready for the next day of analysis. Performing successful checks during analysis ensures that samples analyzed prior to the check were not affected by contamination in the probe. As a further check of proper instrument decontamination, the low-concentration NIST standard (with lead concentration below the instrument detection limit) will be periodically analyzed. A result for lead below the detection limit will confirm that the probe is clean.	If the instrument blank check fails, then the results for samples analyzed between the failed check and the previous successful check will be deemed invalid. The corresponding samples will be re-analyzed upon cleaning (decontaminating) the instrument probe.

Method Blank	To verify that samples are not cross-contaminated during the sample preparation process and that laboratory decontamination procedures are effective. Performed by analyzing a "clean" sample after undergoing the sample preparation process as regular samples.	The method blank check will be performed ongoing during analysis. "Clean" site samples will be used as the medium for the check – i.e. samples with "ND" (below the display threshold of the instrument) results for lead and/or results for lead well below 3 standard deviations. The existence of these "clean" samples following samples with positive results for lead confirms that contamination is not being spread by the sample preparation process.	If method checks fail, then the results for samples analyzed since the previous successful check will be deemed invalid. The corresponding samples will be re-analyzed upon identifying and correcting the cause of cross-contamination.
Precision Check	To verify the ability of the instrument to reproduce results for target analytes. Performed by analyzing standards in replicate and then calculating relative standard deviation (RSD).	The precision check will be performed once each day (per Method 6200) by analyzing a NIST standard sample 5 times in replicate. The RSD will then be calculated. An acceptable RSD is less than 20%.	If the instrument cannot ensure precision within the acceptable RSD, samples prior to the failed precision check will be deemed invalid. The corresponding samples will be re-analyzed upon making the appropriate adjustments to the instrument.

Table 3-2. Project-Specific Method Detection Limits

Element	Detection Limit Cd-109 Source	Detection Limit Am-241 Source
Lead	50 PPM	---
Copper	120 PPM	---
Barium	---	100 PPM
Zinc	110 PPM	---
Tin	---	90 PPM

NOTES:

- The detection limits presented above are based on replicate analysis of the low-concentration NIST Standard (No. 2709) using a count time of 130 seconds for the Cd-109 source, 40 seconds for the Am-241 source, and 40 seconds for the Fe-55 source.
- Tin is not a component of the low-concentration NIST standard. Therefore, the detection limit is estimated using results from low-concentration site samples.

Table 4-1. Summary of XRF Field Screening Results for Metals

Metal	No. of Samples	No. of Samples "BD"	Kansas RSK Residential Level - Soil	No. of Samples > KS RSK	Location(s) of Sample(s) > KS RSK
Barium	58	0	5,500 PPM	0	---
Copper	58	18	2,900 PPM	0	---
Lead	58	10	400 PPM	2	INC10 INC13
Tin	58	46	---	---	---
Zinc	58	12	23,000 PPM	0	---

NOTES:

BD = Low results below the display threshold of XRF spectrometer

Kansas RSK Residential Levels taken from table provided in Statement of Work (March 21, 2001).

Table 4-2. Summary of Confirmatory Analytical Results for Metals

Metal	Low Conc. (PPM)	High Conc. (PPM)	Kansas RSK Residential Level – Soil	No. of Samples > KS RSK	Location(s) of Sample(s) > KS RSK
Antimony	ND(2.0)	ND(2.0)	31 PPM	0	---
Arsenic	2.9	23.3	11 / 29 PPM Soil Grd H2O to Soil	3	INC13 INC14 INC15
Copper	7.6	88.2	2,900 PPM	0	---
Lead	10.9	488	400 PPM	1	INC10
Mercury	ND(0.1)	0.2	2 PPM	0	---
Zinc	37.6	1,380	23,000 PPM	0	---

NOTES:

The above data excludes sample INC100006-L due to anomalously high result for copper.

Kansas RSK Residential Levels taken from table provided in Statement of Work (March 21, 2001).

The following national ranges and averages for inorganics in soil [taken from *Hazardous Waste Land Treatment*, U.S. Environmental Protection Agency, Office of Surface Water (OSWGR), SW-274, April 1983]:

- Antimony – 2 – 10 PPM
- Arsenic – 1 – 50 PPM (avg. 5 PPM)
- Copper – 2 – 100 PPM (avg. 30 PPM)
- Lead – 2 – 200 PPM (avg. 10 PPM)
- Mercury – 0.01 – 0.3 PPM (avg. 0.03 PPM)
- Zinc – 10 – 300 PPM (avg. 50 PPM)

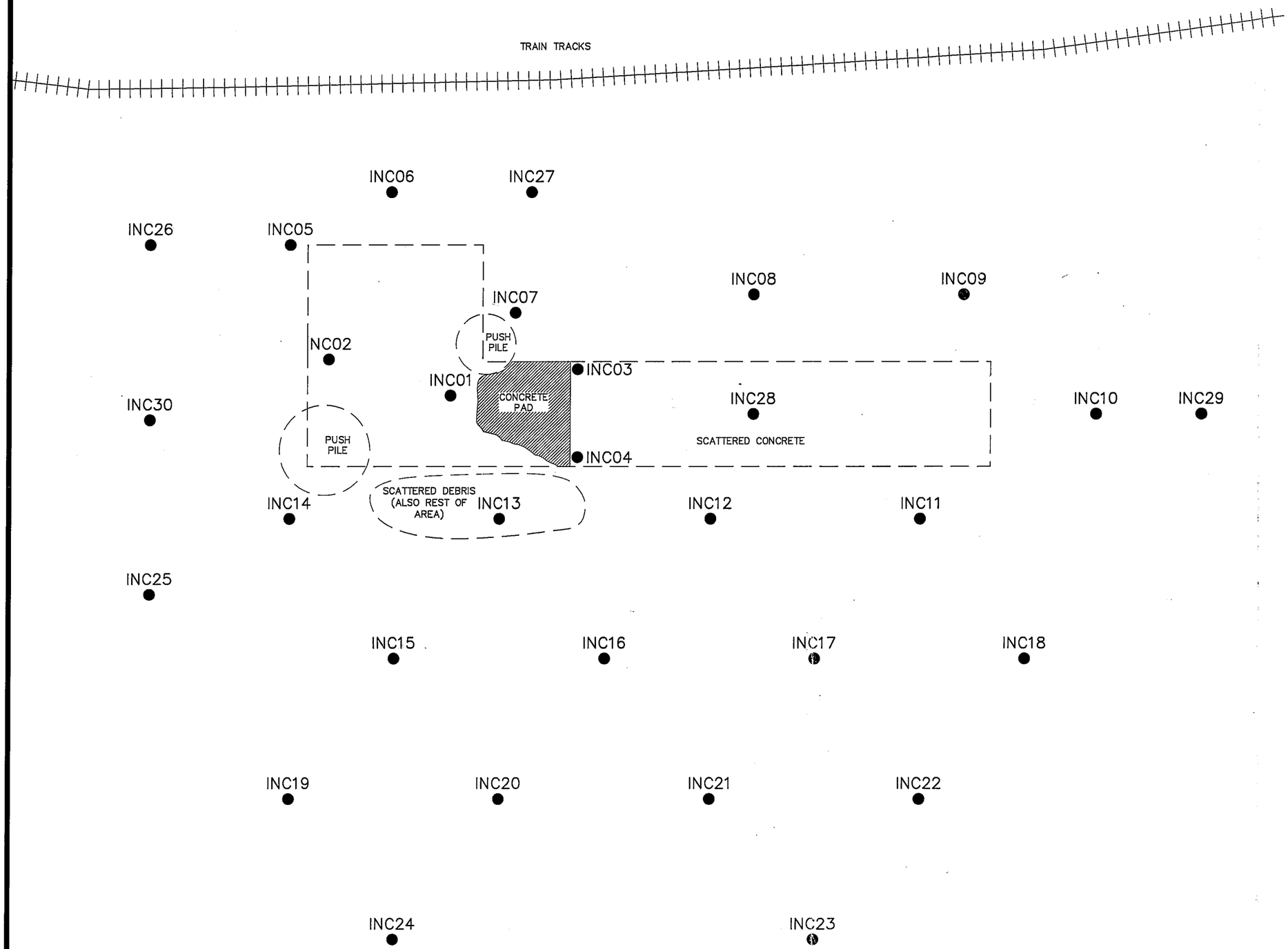
Table 4-3. Summary of Correlation Between XRF Results and Confirmatory Results

Element	Average %D	Correlation Coefficient (r^2)
Copper	-61%	0.82
Lead	-39%	0.95
Zinc	-13%	0.94

NOTES:

- %D = Percent difference from XRF result [calculated by (Conf Result – XRF Result) / (XRF Result) x 100]
- A positive %D indicates that the confirmatory result was greater than the XRF results. Conversely, a negative %D indicates that the XRF result was greater than the confirmatory result.
- The above does not incorporate the result for INC100006-L, due to an anomalously high result for copper.
- Correlation data for antimony is not applicable since all confirmatory results were ND.
- According to Section 9.7 of Method 6200 (EPA, 1998): "The correlation coefficient (r^2) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r^2 is 0.9 or greater ..., the data could potentially meet definitive level data criteria."

FIGURES



LEGEND:

INC29● SAMPLE LOCATIONS

— — — APPROXIMATE LIMITS OF FORMER FOUNDATION BASED ON VISUAL OBSERVATION OF CONCRETE/SLAB REMNANTS

NOTE:

1. FOUNDATION LIMITS AND SAMPLE LOCATION ARE APPROXIMATE.

N

30 0 30 60

SCALE FEET

SCALE IS APPROXIMATE

Arrowhead Contracting Inc.
Overland Park, Kansas 66213

CLIENT: FORT RILEY DES

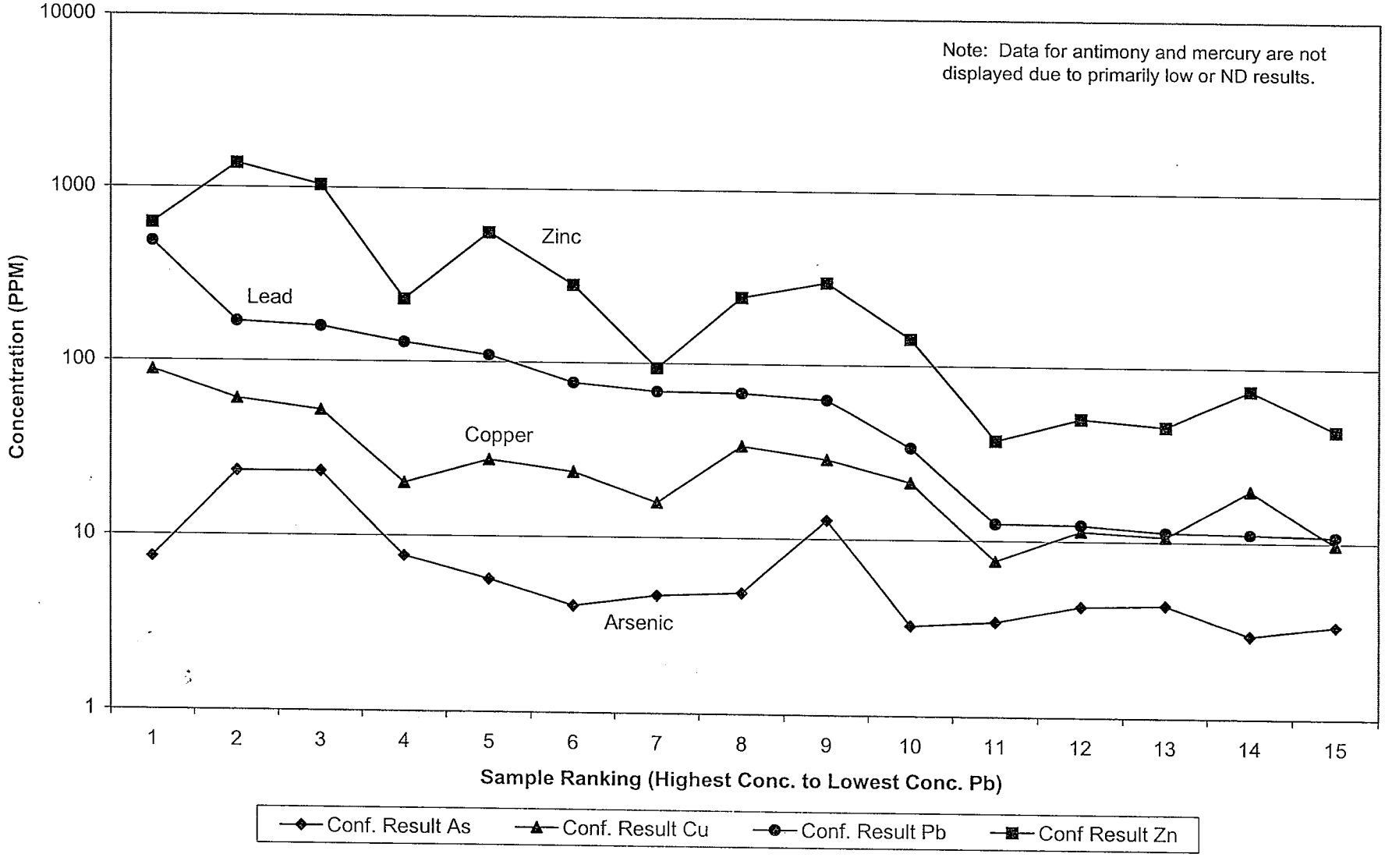
LOCATION: FORT RILEY, KANSAS

TITLE: SAMPLE LOCATIONS

DRAWN BY	CHK'D. BY	APPROVED BY
R.A.D.	S.F.S.	
PROJ. NO.	DATE	FIG. NO.
01-224	4/12/01	1-1

April 19, 2001 11:19.17 am (RAD)
H:\1999033.86\FIGURE-1.dwg

Figure 4-1. Comparison of Lead Results to Other Metals



APPENDIX A

XRF FIELD SCREENING AND CONFIRMATORY ANALYSIS RESULTS – ALL DATA

XRF Field Screening Results
Ft. Riley Incinerator Site

Date Anal.	Time Anal.	Sample ID	Result Cu	SD Cu	Result Zn	SD Zn	Result Pb	SD Pb	Result Ba	SD Ba	Result Sn	SD Sn
4/2/01	9:58	INC010006	63	33	38	30.7	BD	BD	762	27.7	37	29.3
4/2/01	14:52	INC020006	44	32.3	45	31.6	23	14	918	30.8	BD	BD
4/2/01	12:50	INC020612	62	32.7	53	31.2	25	14.3	850	29.3	BD	BD
4/2/01	12:00	INC021224	68	33	BD	BD	21	14	891	30.1	BD	BD
4/2/01	13:29	INC030006	BD	BD	197	39.5	74	17.5	595	25.1	BD	BD
4/2/01	10:18	INC040006	36	33	292	44.4	157	21.7	468	22.8	37	27.6
4/2/01	15:44	INC050006	BD	BD	211	39.7	40	15.3	940	31.4	BD	BD
4/2/01	14:39	INC050612	54	32.9	134	36	17	13.8	593	24.6	BD	BD
4/2/01	16:10	INC060006	135	39.4	393	47.9	120	19.6	373	20.6	BD	BD
4/2/01	11:55	INC070006	BD	BD	940	65.3	200	23.6	389	20.9	BD	BD
4/2/01	13:41	INC080006	48	33.5	111	35.6	108	19.6	943	31.3	BD	BD
4/2/01	9:46	INC080612	70	33.7	66	32.1	30	14.6	785	28.1	BD	BD
4/2/01	11:01	INC081224	34	31.4	54	31.8	50	16	818	28.9	BD	BD
4/2/01	15:51	INC090006	52	35.7	255	44.6	123	21.3	754	29.4	BD	BD
4/2/01	12:14	INC090612	81	36.3	84	35.4	20	14.8	932	31.7	BD	BD
4/2/01	14:04	INC100006	123	38.6	556	53.3	544	35.4	716	28.2	70	31.5
4/2/01	12:20	INC100612	BD	BD	142	36.8	206	24	895	30.8	71	32.7
4/2/01	12:07	INC110001	81	41.7	980	73.5	204	27.8	1447	43.2	BD	BD
4/2/01	11:12	INC110612	40	33.8	282	44.3	168	23.6	1155	36.3	BD	BD
4/2/01	15:15	INC120006	100	43.6	583	62.3	232	10.3	1938	51.6	52	37.1
4/2/01	13:35	INC120612	BD	BD	97	33.8	BD	BD	870	29.8	BD	BD
4/2/01	14:17	INC130006	108	48.1	2010	106	272	32.8	1737	50.2	44	39.9
4/2/01	10:26	INC130612	255	62.3	2120	117	515	45.4	1852	55.2	55	45.1
4/2/01	15:20	INC140006	76	34.5	120	35.9	45	16.2	820	29.2	37	29.9
4/2/01	11:32	INC140612	104	38.6	302	45.1	72	18.6	957	32.6	BD	BD
4/2/01	12:37	INC141224	82	40.5	569	59.2	149	24.8	1640	45.4	BD	BD
4/2/01	15:31	INC150006	158	50.8	1570	96.3	365	37.4	1155	41.6	97	41.6
4/2/01	14:57	INC160006	BD	BD	68	33.6	BD	BD	826	29.9	BD	BD
4/2/01	9:40	INC160612	BD	BD	91	34.7	32	15.2	969	31.9	BD	BD
4/2/01	9:52	INC170006	89	37.2	60	34	BD	BD	1052	33.5	BD	BD
4/2/01	14:31	INC170612	74	33.8	BD	BD	BD	BD	811	28.8	BD	BD
4/2/01	11:26	INC180006	47	32.6	63	32.5	51	16.2	802	28.9	BD	BD
4/2/01	13:47	INC180612	BD	BD	BD	BD	55	16.7	875	30.2	BD	BD
4/2/01	11:39	INC190006	BD	BD	47	31.2	16	14.3	858	29.6	BD	BD
4/2/01	11:49	INC190612	BD	BD	BD	BD	BD	BD	821	29.2	BD	BD
4/2/01	15:38	INC191224	BD	BD	66	32.8	28	15	879	30.4	67	32
4/2/01	11:20	INC200006	BD	BD	45	32.1	25	14.9	946	31.6	BD	BD
4/2/01	14:25	INC200612	75	34	74	32.7	33	14.7	811	28.8	BD	BD
4/2/01	10:11	INC210006	50	33.3	104	35.2	BD	BD	910	30.9	BD	BD
4/2/01	14:46	INC210612	77	34.5	BD	BD	51	16.5	812	28.9	BD	BD
4/2/01	14:11	INC211224	91	34.4	BD	BD	36	14.8	824	28.8	37	29.7
4/2/01	16:04	INC220006	80	34.5	57	32.3	59	17	869	30.2	BD	BD
4/2/01	15:09	INC220612	51	32.7	BD	BD	BD	BD	857	29.7	BD	BD
4/2/01	15:26	INC230006	BD	BD	BD	BD	29	14.6	748	27.8	BD	BD
4/2/01	15:03	INC230612	BD	BD	82	33.2	BD	BD	760	28.2	BD	BD
4/2/01	13:59	INC240006	BD	BD	53	32.1	32	14.7	893	30.3	BD	BD
4/2/01	11:07	INC240612	BD	BD	94	34.3	15	14.6	848	29.7	BD	BD
4/2/01	13:54	INC250006	41	32.5	127	36.1	37	15.8	803	29.1	BD	BD
4/2/01	10:50	INC250612	93	35.3	BD	BD	35	14.9	797	28.6	BD	BD

XRF Field Screening Results
Ft. Riley Incinerator Site

Date Anal.	Time Anal.	Sample ID	Result Cu	SD Cu	Result Zn	SD Zn	Result Pb	SD Pb	Result Ba	SD Ba	Result Sn	SD Sn
4/2/01	11:44	INC251224	64	33.8	BD	BD	BD	BD	892	30.4	43	31
4/2/01	10:56	INC260006	132	37.5	51	31.5	18	14.3	810	28.5	BD	BD
4/2/01	12:32	INC260612	53	31.6	BD	BD	40	14.6	781	27.9	BD	BD
4/2/01	9:33	INC270006	BD	BD	269	43.1	119	19.3	308	18.7	BD	BD
4/2/01	15:58	INC280006	59	34.8	448	50	150	21.2	462	22.2	BD	BD
4/2/01	10:05	INC290006	BD	BD	BD	BD	36	15	831	28.9	BD	BD
4/2/01	10:32	INC290612	36	30.8	35	30.2	20	13.4	787	27.7	BD	BD
4/2/01	10:45	INC300006	84	35.9	135	32.1	36	15.4	633	26	BD	BD
4/2/01	12:44	INC300612	68	33.8	228	40.2	45	16.9	902	30.6	BD	BD

Notes: Results are reported in parts per million (PPM)
SD = Standard deviation
BD = Low results suppressed (not displayed) by Spectrace 9000
ND (2.0) = Not detected (detection limit)

General: According to SW-846 Method 6200 - A measurement above the average calculated or manufacturer's detection limit, but smaller than three times its SD, should not be used as a quantitative measurement. Conversely, if the measurement is below the average calculated or manufacturer's detection limit, but greater than three times its associated SD, it should be coded as an estimated value.

Per SW-846 Method 6200 (Section 9.6) detection limits were calculated based on analysis of the low-concentration NIST sample. Approximate detection limits were: Pb - 50 PPM, Cu - 120 PPM, Ba - 100 PPM, Zn - 110 PPM, and Sn - 90 PPM.

Results of Confirmatory Analyses and Analyses of Other Metals
Ft. Riley Former Incinerator Site

Date Anal. XRF	XRF Sample ID	XRF Result Cu	XRF SD Cu	XRF Result Pb	XRF SD Pb	XRF Result Zn	XRF SD Zn	Confirmatory ID	Date Submitted to Lab	Conf. Result Sb	Conf. Result As	Conf. Result Cu	Conf. Result Pb	Conf. Result Zn	Conf. Result Hg
4/2/01	INC010006	63	33	BD	BD	38	30.7	INC010006-L	4/3/01	ND(2.0)	2.9	20	11.2	74	ND(0.1)
4/2/01	INC030006	BD	BD	74	17.5	197	39.5	INC030006-L	4/3/01	ND(2.0)	3.2	21.5	33.8	144	0.1
4/2/01	INC060006	135	39.4	120	19.6	393	47.9	INC060006-L	4/3/01	ND(2.0)	4.8	33.8	67.8	245	ND(0.1)
4/2/01	INC070006	BD	BD	200	23.6	940	65.3	INC070006-L	4/3/01	ND(2.0)	5.6	27.5	110	561	0.2
4/2/01	INC080006	48	33.5	108	19.6	111	35.6	INC080006-L	4/3/01	ND(2.0)	4.6	16	68.7	94.1	ND(0.1)
4/2/01	INC100006	123	38.6	544	35.4	556	53.3	INC100006-L	4/3/01	ND(2.0)	5.5	2320	448	663	0.2
4/2/01	INC100006	123	38.6	544	35.4	556	53.3	INC100006-LD	4/3/01	ND(2.0)	7.4	88.2	488	624	0.2
4/2/01	INC110612	40	33.8	168	23.6	282	44.3	INC110612-L	4/3/01	ND(2.0)	7.6	20.2	130	231	ND(0.1)
4/2/01	INC130006	108	48.1	272	32.8	2010	106	INC130006-L	4/3/01	ND(2.0)	23.3	51.9	160	1040	ND(0.1)
4/2/01	INC141224	82	40.5	149	24.8	569	59.2	INC141224-L	4/3/01	ND(2.0)	12.9	28.7	62.5	301	ND(0.1)
4/2/01	INC150006	158	50.8	365	37.4	1570	96.3	INC150006-L	4/3/01	ND(2.0)	23.3	60	170	1380	0.2
4/2/01	INC190612	BD	BD	BD	BD	BD	BD	INC190612-L	4/3/01	ND(2.0)	4.3	10.7	11.4	45.6	ND(0.1)
4/2/01	INC190612	51	32.7	BD	BD	BD	BD	INC220612-L	4/3/01	ND(2.0)	4.2	11.5	12.5	50.2	ND(0.1)
4/2/01	INC220612	51	32.7	BD	BD	BD	BD	INC220612-LD	4/3/01	ND(2.0)	4.1	11.3	11.9	48.7	ND(0.1)
4/2/01	INC240612	BD	BD	15	14.6	94	34.3	INC240612-L	4/3/01	ND(2.0)	3.3	9.8	10.9	43.8	ND(0.1)
4/2/01	INC260612	53	31.6	40	14.6	BD	BD	INC260612-L	4/3/01	ND(2.0)	3.4	7.6	12.6	37.6	ND(0.1)
4/2/01	INC280006	59	34.8	150	21.2	448	50	INC280006-L	4/3/01	ND(2.0)	4	23.7	76.5	284	ND(0.1)

Notes: Results are reported in parts per million (PPM).
SD = Standard deviation
BD = Low results suppressed (not displayed) by Spectrace 9000
ND (2.0) = Not detected (detection limit)

General: According to SW-846 Method 6200 - A measurement above the average calculated or manufacturer's detection limit, but smaller than three times its SD, should not be used as a quantitative measurement. Conversely, if the measurement is below the average calculated or manufacturer's detection limit, but greater than three times its associated SD, it should be coded as an estimated value.

Per SW-846 Method 6200 (Section 9.6) detection limits were calculated based on analysis of the low-concentration NIST sample. Approximate detection limits were: Pb - 50 PPM, Cu - 120 PPM, Ba - 100 PPM, and Zn - 110 PPM.

Correlation Between XRF Results and Confirmatory Results
Ft. Riley Former Incinerator Site

Sample ID	XRF Result Cu	Conf. Result Cu	XRF Result Pb	Conf. Result Pb	XRF Result Zn	Conf. Result Zn	Correlation (%D from XRF Result) Cu	Correlation (%D from XRF Result) Pb	Correlation (%D from XRF Result) Zn
INC010006	63	20	**15**	11.2	38	74	-68	-25	95
INC030006	**40**	21.5	74	33.8	197	144	-46	-54	-27
INC060006	135	33.8	120	67.8	393	245	-75	-44	-38
INC070006	**40**	27.5	200	110	940	561	-31	-45	-40
INC080006	48	16	108	68.7	111	94.1	-67	-36	-15
INC100006	123	88.2	544	488	556	624	-28	-10	12
INC110612	40	20.2	168	130	282	231	-50	-23	-18
INC130006	108	51.9	272	160	2010	1040	-52	-41	-48
INC141224	82	28.7	149	62.5	569	301	-65	-58	-47
INC150006	158	60	365	170	1570	1380	-62	-53	-12
INC190612	**40**	10.7	**15**	11.4	**40**	45.6	-73	-24	14
INC220612	51	11.3	**15**	11.9	**40**	48.7	-78	-21	22
INC240612	**40**	9.8	15	10.9	94	43.8	-76	-27	-53
INC260612	53	7.6	40	12.6	**40**	37.6	-86	-69	-6
INC280006	59	23.7	150	76.5	448	284	-60	-49	-37
						Average:	-61	-39	-13

Notes:

%D = Percent difference from XRF result

XRF results originally BD (below display threshold of instrument) are assigned a value of approximately one third the XRF detection limit for purposes of calculating the %D. The affected results are represented in bold.

For INC100006, the duplicate confirmatory sample result (INC100006-LD) was used to calculate correlation due to anomalously high copper result for INC100006-L.

Results of Calibration Verification Checks and Precision Checks
Ft. Riley Former Incinerator Site

Date Anal.	QC Check ID	Time Anal.	Result Pb	SD Pb	Result Zn	SD Zn	Result Ba	SD Ba	QC Check Description	%D Pb	%D Zn	%D Ba	Precision SD	Precision RSD
4/2/01	NIST2709-3	9:22	16	13.1	76	33.4	800	29.3	Standard Check	NA	NA	-17.4		
4/2/01	NIST2710-1	8:55	5380	132	6350	186	---	---	Standard Check	-2.7	-8.7	NA		
4/2/01	NIST2711-1	9:03	1193	58.1	369	54	715	28.5	Standard Check	2.7	5.4	-1.5		
4/2/01	NIST2711-2	13:22	1223	51.8	293	44.4	675	27.7	Standard Check	5.2	-16.3	-7.0		
4/2/01	NIST2711-3	16:19	1170	50.8	---	---	---	---	Precision/Calibration Check	0.7	---	---		
4/2/01	NIST2711-4	16:25	1195	51.5	---	---	---	---	Precision Check	2.8	---	---		
4/2/01	NIST2711-5	16:29	1282	53.3	---	---	---	---	Precision Check	10.3	---	---		
4/2/01	NIST2711-6	16:35	1121	49.9	---	---	---	---	Precision Check	-3.5	---	---		
4/2/01	NIST2711-7	16:40	1039	47.9	---	---	---	---	Precision Check	-10.6	---	---	89.9	7.7

Notes:

BD = Low result suppressed (not displayed) by Spectrace 9000
NA = Not applicable; result below the detection limit
SD = Standard deviation
RSD = Relative standard deviation
%D = Percent difference from certified (true) value

NIST certified concentrations (PPM):

NIST2709 (low concentration) = Pb 18.9 +/- 0.5, Zn 106 +/-3, Ba 968 +/- 40
NIST 2711 (medium concentration) = Pb 1162 +/- 31, Zn 350.4 +/- 4.8, Ba 726 +/- 38
NIST 2710 (high concentration) = Pb 5532 +/- 80, Zn 6952 +/- 91, Ba 707 +/- 51

General:

According to SW-846 Method 6200, the measured value should be within +/- 20% (%D) of the true value for the calibration verification check to be acceptable.

According to SW-846 Method 6200, for XRF data to be adequately precise, the RSD should not be greater than 20 percent.

Continental Analytical Services, Inc.

04/17/2001

Arrowhead Contracting
Attn: Scott Siegwald
12920 Metcalf Ste.150
Overland Park, KS 66213

Date Received: 04/04/2001
Continental File No.: 7121
Continental Order No.: 69906
Your P.O./Project No.: 2328

Dear Mr. Siegwald:

This laboratory report consisting of 13 pages contains the analytical results for the following samples:

CAS LAB ID #	SAMPLE DESCRIPTION	SAMPLE TYPE	DATE SAMPLED
01040228	INC110612-L	Solid	03/23/2001
01040229	INC150006-L	Solid	03/23/2001
01040230	INC220612-L	Solid	03/23/2001
01040231	INC220612-LD	Solid	03/23/2001
01040232	INC100006-L	Solid	03/23/2001
01040233	INC100006-LD	Solid	03/23/2001
01040234	INC260612-L	Solid	03/23/2001
01040235	INC130006-L	Solid	03/23/2001
01040236	INC190612-L	Solid	03/23/2001
01040237	INC060006-L	Solid	03/23/2001
01040238	INC240612-L	Solid	03/23/2001
01040239	INC010006-L	Solid	03/23/2001
01040240	INC280006-L	Solid	03/23/2001
01040241	INC070006-L	Solid	03/23/2001
01040242	INC141224-L	Solid	03/23/2001
01040243	INC030006-L	Solid	03/23/2001
01040244	INC080006-L	Solid	03/23/2001

Thank you for choosing Continental for this project. If you have any questions, please contact me at (800)-535-3076.

CONTINENTAL ANALYTICAL SERVICES, INC.

Brian T. O'Donnell
Project Manager

1804 Glendale Road • Salina, Kansas 67401-6675
785-827-1273 • 800-535-3076 • FAX 785-823-7830

Continental
Analytical Services, Inc.

Client: Arrowhead Contracting
Attn: Scott Siegwald
12920 Metcalf Ste.150
Overland Park, KS 66213

Date Sample Rptd: 04/17/2001
Date Sample Recd: 04/04/2001
Continental File No: 7121
Continental Order No: 69906
Client P.O.: 2328

Lab Number: 01040228
Sample Description: INC110612-L

Date Sampled: 03/23/2001
Time Sampled: 1330

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	7.6	mg/kg	04/13/2001	4866/26
Copper, Total	20.2	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	130.	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/343
Zinc, Total	231.	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040228

Lab Number: 01040229
Sample Description: INC150006-L

Date Sampled: 03/23/2001
Time Sampled: 1410

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	23.3	mg/kg	04/13/2001	4866/26
Copper, Total	60.0	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	170.	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	0.2	mg/kg	04/16/2001	4425/343
Zinc, Total	1380.	mg/kg	04/13/2001	4866/27

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B

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CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT

Client: Arrowhead Contracting
Lab Number: 01040229

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040229

Lab Number: 01040230
Sample Description: INC220612-L

Date Sampled: 03/23/2001
Time Sampled: 1520

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.2	mg/kg	04/13/2001	4866/26
Copper, Total	11.5	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	12.5	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	50.2	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040230

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CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 4

Client: Arrowhead Contracting

Lab Number: 01040231
Sample Description: INC220612-LD

Date Sampled: 03/23/2001
Time Sampled: 1520

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.1	mg/kg	04/13/2001	4866/26
Copper, Total	11.3	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	11.9	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	48.7	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040231

Lab Number: 01040232
Sample Description: INC100006-L

Date Sampled: 03/23/2001
Time Sampled: 1320

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	5.5	mg/kg	04/13/2001	4866/26
Copper, Total	2320.	mg/kg	04/13/2001	4866/27
Lead, Total (ICP)	448.	mg/kg	04/13/2001	4866/26
Mercury, Total	0.2	mg/kg	04/16/2001	4425/344
Zinc, Total	663.	mg/kg	04/13/2001	4866/27

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B

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Continental Analytical Services, Inc.

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 5

Client: Arrowhead Contracting
Lab Number: 01040232

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040232

Lab Number: 01040233
Sample Description: INC100006-LD

Date Sampled: 03/23/2001
Time Sampled: 1320

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	7.4	mg/kg	04/13/2001	4866/26
Copper, Total	88.2	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	488.	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	0.2	mg/kg	04/16/2001	4425/344
Zinc, Total	624.	mg/kg	04/13/2001	4866/27

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040233

Lab Number: 01040234
Sample Description: INC260612-L

Date Sampled: 03/23/2001
Time Sampled: 1600

Analysis	Concentration	Units	Date Analyzed	Book/Page

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Continental Analytical Services, Inc.

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 6

Client: Arrowhead Contracting
Lab Number: 01040234
Sample Description: INC260612-L

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	3.4	mg/kg	04/13/2001	4866/26
Copper, Total	7.6	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	12.6	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	37.6	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040234

Lab Number: 01040235
Sample Description: INC130006-L

Date Sampled: 03/23/2001
Time Sampled: 1350

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	23.3	mg/kg	04/13/2001	4866/26
Copper, Total	51.9	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	160.	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	1040.	mg/kg	04/13/2001	4866/27

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B

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CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 7

Client: Arrowhead Contracting
Lab Number: 01040235

ICP Metals Total Preparation Analyst/Method	SKR	3050B
Mercury Total Preparation Analyst/Method	AMB	7471A
Antimony Total Preparation Analyst/Method	SKR	3050B

Conclusion of Lab Number: 01040235

Lab Number: 01040236
Sample Description: INC190612-L

Date Sampled: 03/23/2001
Time Sampled: 1450

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.3	mg/kg	04/13/2001	4866/26
Copper, Total	10.7	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	11.4	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	45.6	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040236

Lab Number: 01040237
Sample Description: INC060006-L

Date Sampled: 03/23/2001
Time Sampled: 1240

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.8	mg/kg	04/13/2001	4866/26
Copper, Total	33.8	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	67.8	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344

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CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 8

Client: Arrowhead Contracting
Lab Number: 01040237
Sample Description: INC060006-L

Analysis	Concentration	Units	Date Analyzed	Book/Page
Zinc, Total	245.	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040237

Lab Number: 01040238
Sample Description: INC240612-L

Date Sampled: 03/23/2001
Time Sampled: 1540

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	3.3	mg/kg	04/13/2001	4866/26
Copper, Total	9.8	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	10.9	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	43.8	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

-Continued-

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 9

Client: Arrowhead Contracting
Lab Number: 01040238

Analysis	Concentration	Units	Date Analyzed	Book/Page

Conclusion of Lab Number: 01040238

Lab Number: 01040239
Sample Description: INC010006-L

Date Sampled: 03/23/2001
Time Sampled: 1150

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	2.9	mg/kg	04/13/2001	4866/26
Copper, Total	20.0	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	11.2	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	74.0	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040239

Lab Number: 01040240
Sample Description: INC280006-L

Date Sampled: 03/23/2001
Time Sampled: 1620

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.0	mg/kg	04/13/2001	4866/26
Copper, Total	23.7	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	76.5	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	284.	mg/kg	04/13/2001	4866/26

-Continued-

Continental Analytical Services, Inc.

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 10

Client: Arrowhead Contracting
Lab Number: 01040240
Sample Description: INC280006-L

Analysis	Concentration	Units	Date Analyzed	Book/Page

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040240

Lab Number: 01040241
Sample Description: INC070006-L

Date Sampled: 03/23/2001
Time Sampled: 1250

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	5.6	mg/kg	04/13/2001	4866/26
Copper, Total	27.5	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	110.	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	0.2	mg/kg	04/16/2001	4425/344
Zinc, Total	561.	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040241

-Continued-

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 11

Client: Arrowhead Contracting

Lab Number: 01040242
Sample Description: INC141224-L

Date Sampled: 03/23/2001
Time Sampled: 1400

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	12.9	mg/kg	04/13/2001	4866/26
Copper, Total	28.7	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	62.5	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	301.	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040242

Lab Number: 01040243
Sample Description: INC030006-L

Date Sampled: 03/23/2001
Time Sampled: 1210

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	3.2	mg/kg	04/13/2001	4866/26
Copper, Total	21.5	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	33.8	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	0.1	mg/kg	04/16/2001	4425/344
Zinc, Total	144.	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B

-Continued-

Continental Analytical Services, Inc.

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 12

Client: Arrowhead Contracting
Lab Number: 01040243

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040243

Lab Number: 01040244
Sample Description: INC080006-L

Date Sampled: 03/23/2001
Time Sampled: 1300

Analysis	Concentration	Units	Date Analyzed	Book/Page
Antimony, Total (ICP)	ND(2.0)	mg/kg	04/12/2001	4866/26
Arsenic, Total (ICP)	4.6	mg/kg	04/13/2001	4866/26
Copper, Total	16.0	mg/kg	04/13/2001	4866/26
Lead, Total (ICP)	68.7	mg/kg	04/13/2001	4866/26
Mercury, Total Soil	ND(0.1)	mg/kg	04/16/2001	4425/344
Zinc, Total	94.1	mg/kg	04/13/2001	4866/26

Analysis	Date Prepared	QC Batch	Analyst	Method(s)
Antimony, Total (ICP)	04/12/2001	010412-1	MAG	6010B
Arsenic, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Copper, Total	04/11/2001	010411-6	MAG	6010B
Lead, Total (ICP)	04/11/2001	010411-6	MAG	6010B
Mercury, Total Soil	04/13/2001	010413-2	AMB	7471A
Zinc, Total	04/11/2001	010411-6	MAG	6010B
ICP Metals Total Preparation Analyst/Method			SKR	3050B
Mercury Total Preparation Analyst/Method			AMB	7471A
Antimony Total Preparation Analyst/Method			SKR	3050B

Conclusion of Lab Number: 01040244

-Continued-

CONTINENTAL ANALYTICAL SERVICES, INC.

LABORATORY REPORT Page: 13

Client: Arrowhead Contracting
Lab Number: 01040244

Analysis	Concentration	Units	Date Analyzed	Book/Page

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986 and the latest promulgated update. ND(), where noted, indicates none detected with the reporting limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.

Clifford J. Baker
Technical Manager

Continental Analytical Services, Inc.

Chain-of-Custody Record

Continental Analytical Services, Inc.
1804 Glendale Rd. • Salina, KS 67401
(785) 827-1273 • (800) 535-3076 • FAX (785) 823-7830

PROJECT #: 01-224

PROJECT NAME: Ft. Riley Soil Characterization

SAMPLED BY (SIGNATURE): [signature]

SAMPLED BY (PRINTED): Scott Siegwald

—SAMPLE INFORMATION—

PARAMETERS

DATE	TIME	C-COMP G-GRAB	FIELD FILTERED Y N	SAMPLE IDENTIFICATION	# OF CONTAINERS	Pb, Cu, Sb, Zn, As, Hg							REMARKS (REQUESTED TURNAROUND, PRESERVATIVE, ETC.)
3/23/01	1330	C	N	INC110612-L	1	X							Standard Turnaround
3/23/01	1410	C	N	INC150006-L	1	X							
3/23/01	1520	C	N	INC220612-L	1	X							
3/23/01	1520	C	N	INC220612-LD	1	X							
3/23/01	1320	C	N	INC100006-L	1	X							
3/23/01	1320	C	N	INC100006-LD	1	X							
3/23/01	1600	C	N	INC260612-L	1	X							
3/23/01	1350	C	N	INC130006-L	1	X							
3/23/01	1450	C	N	INC190612-L	1	X							
3/23/01	1240	C	N	INC060006-L	1	X							

RELINQUISHED BY (SIGNATURE): [signature] RELINQUISHED BY (PRINTED): DATE: 4/3/01 TIME: 1700

RECEIVED BY (SIGNATURE): RECEIVED BY (PRINTED): DATE: TIME:

RELINQUISHED BY (SIGNATURE): RELINQUISHED BY (PRINTED): DATE: TIME:

RECEIVED BY (SIGNATURE): RECEIVED BY (PRINTED): DATE: TIME:

RECEIVED AT LABORATORY BY (SIGNATURE/PRINTED): DATE: TIME:

SHIPPED VIA: Seal #:
Airbill #: Seal Date:

REPORT TO:
Attention: Scott Siegwald
Address:
Phone #: FAX #: (913) 814-9997

INVOICE TO: Arrowhead Contracting
Attention: Tamuya Dennistou
Address: 12920 Metcalf Ave, Suite 150
Overland Park, KS 66213
Phone #: (913) 814-9997
Purchase Order No.:
CAS Price Quote No.:
FAX #: (913) 814-9997

White -- Laboratory Copy Yellow -- Client Copy

Chain-of-Custody Record

Continental Analytical Services, Inc.
1804 Glendale Rd. • Salina, KS 67401
(785) 827-1273 • (800) 535-3076 • FAX (785) 823-7830

PROJECT #: 01-224

PROJECT NAME: Ft. Riley Soil Characterization

SAMPLED BY (SIGNATURE): [signature]

SAMPLED BY (PRINTED): Scott Siegwald

—SAMPLE INFORMATION—

DATE	TIME	C-COMP G-GRAB	FIELD FILTERED Y N	SAMPLE IDENTIFICATION	# OF CONTAINERS	PARAMETERS: Pb, Cu, Sb, Zn, As, Hg							REMARKS (REQUESTED TURNAROUND, PRESERVATIVE, ETC.)
3/23/01	1540	C	N	INC240612-L	1	X							Standard Turnaround
3/23/01	1150	C	N	INC010006-L	1	X							
3/23/01	1620	C	N	INC280006-L	1	X							
3/23/01	1250	C	N	INC070006-L	1	X							
3/23/01	1400	C	N	INC141224-L	1	X							
3/23/01	1210	C	N	INC030006-L	1	X							
3/23/01	1300	C	N	INC080006-L	1	X							
3/23/01	1300	C	N	INC080006-MS/MSD	1	[illegible]							Provided for Lab QA

RELINQUISHED BY (SIGNATURE): [signature] RELINQUISHED BY (PRINTED): DATE: 4/3/01 TIME: 1700

RECEIVED BY (SIGNATURE): RECEIVED BY (PRINTED): DATE: TIME:

RELINQUISHED BY (SIGNATURE): RELINQUISHED BY (PRINTED): DATE: TIME:

RECEIVED BY (SIGNATURE): RECEIVED BY (PRINTED): DATE: TIME:

RECEIVED AT LABORATORY BY (SIGNATURE/PRINTED): DATE: TIME:

SHIPPED VIA: Airbill #: Seal #: Seal Date:

REPORT TO:
Attention:
Address: See page 1 of 2.
Phone #: FAX #:

INVOICE TO:
Attention:
Address: See page 1 of 2
Phone #:
Purchase Order No.:
CAS Price Quote No.:
FAX #:

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APPENDIX B

SAMPLE COLLECTION FIELD SHEETS

SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: Inc-01 Start Depth: 0 ft. Finish Depth: 6" ft. Sample Date: 03/23/ Time: 1150	Sampling Personnel: Andy Arnold Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

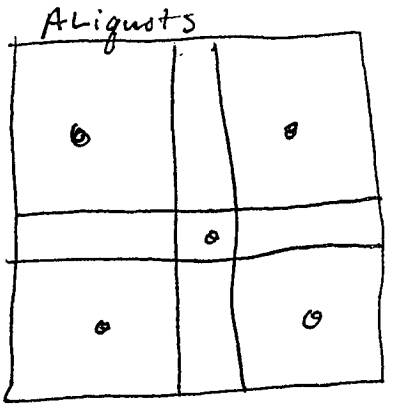
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

Inc-01-0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-02 Start Depth: 0 ft. Finish Depth: 2 ft. Sample Date: 03/23/ Time: 1200	Sampling Personnel: Andy Arnold, Bob Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

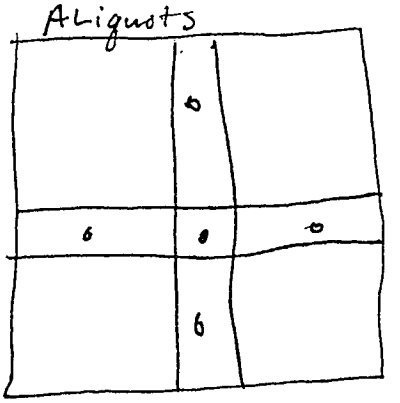
Notes/Sketch Map:

Samples Collected

INC-020006

INC-02-0612

INC-02-1224



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: InC-03 Start Depth: 0 ft Finish Depth: 6" ft Sample Date: 03/23/ Time: 1210	Sampling Personnel: Andy Arnold Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: Soil probe Composite? Y	
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

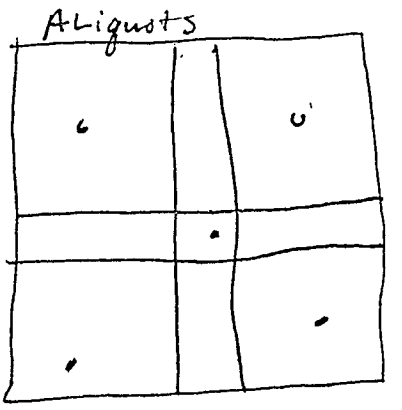
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-03-0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: InC-04 Start Depth: 0 ft. Finish Depth: 6" ft. Sample Date: 03/23/ Time:	Sampling Personnel: Andy Arnold, Bob Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

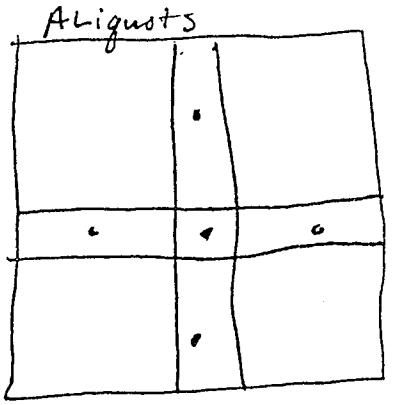
Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected
InC - 04 - 0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Bob Boyer
Location: INC-05	
Start Depth: 0 ft. Finish Depth: 1 ft.	
Sample Date: 03/23/ Time: 1230	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y
Weather CLR P. CLDY CLDY FOG	
Temp 55 °F Wind Calm Mod High	
Precip Rain Lite Mod High	
Snow Lite Mod High	
Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

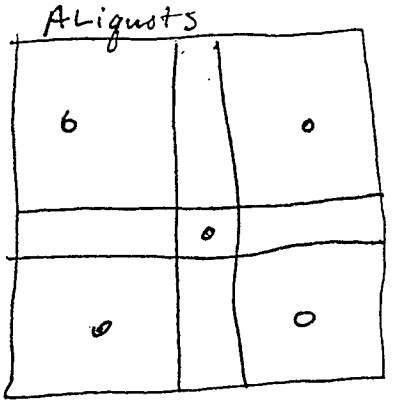
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-05-0006

INC-05-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: Inc-06 Start Depth: 0 ft. Finish Depth: 6" ft. Sample Date: 03/23/ Time: 1240	Sampling Personnel: Andy Arnold, Beth Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

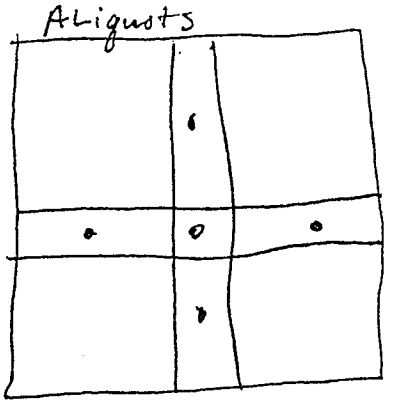
Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected
Inc-06- 0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: InC - 07 Start Depth: 0 ft. Finish Depth: 6" ft. Sample Date: 03/23/ Time: 1250	Sampling Personnel: Andy Arnold, Blake Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

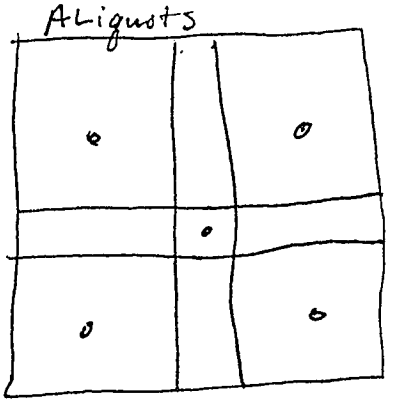
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC - 07 - 0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: Inc-08 Start Depth: 0 ft. Finish Depth: 2 ft. Sample Date: 03/23/ Time: 1300	Sampling Personnel: Andy Arnold Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

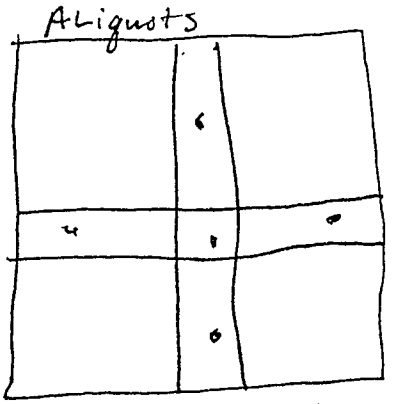
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

Inc-08-0006
Inc-08-0612
Inc-08-1214



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Bob Boyer
Location: InC - 09	
Start Depth: 0 ft. Finish Depth: 6" ft.	
Sample Date: 03/23/ Time: 1310	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

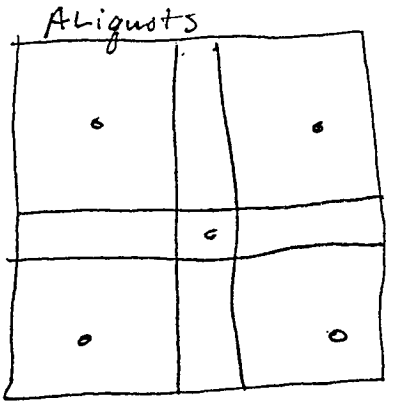
Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected
InC - 09 - 0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: 1 Type: SO Location: InC-1D Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1320	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

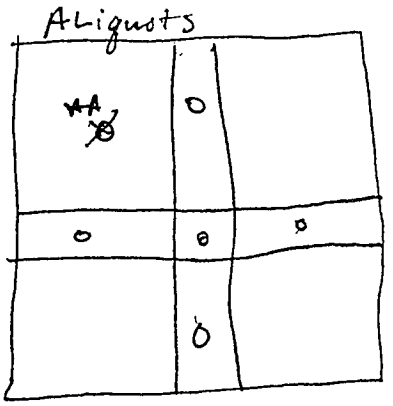
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-10-0006

InC-10-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: Inc	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: Inc - 11 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1330	Sampling Personnel: Andy Arnold, Brett Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

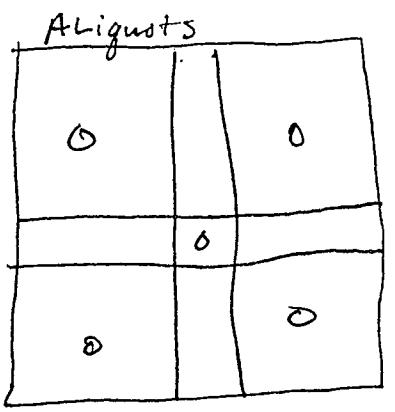
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

Inc-c1-0006

Inc-11-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold Brad Boyer
Location: INC 12	
Start Depth: 0 ft. Finish Depth: 6" ft.	
Sample Date: 03/23/01 Time: 1340	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

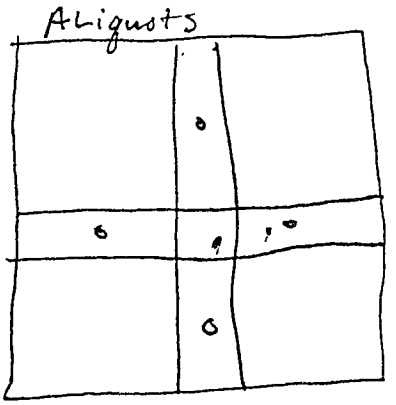
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-12-0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Brad Boyer
Location: InC-13	
Start Depth: 0 ft. Finish Depth: 1 ft.	
Sample Date: 03/23/ Time: 1350	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P.CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

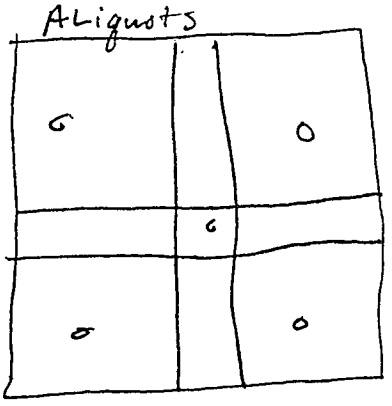
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-13-0006

InC-13-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Brad Boyer
Location: INC-14	
Start Depth: 0 ft. Finish Depth: 2 ft.	
Sample Date: 03/23/ Time: 1400	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P.CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

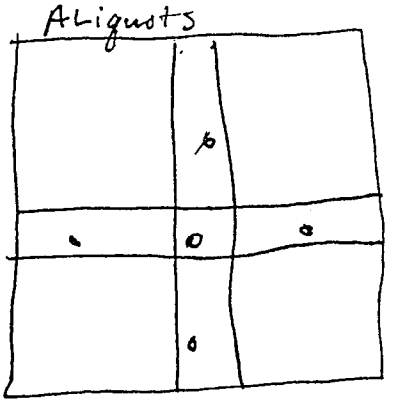
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-14-0006
INC-14-0612
INC-1224



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Bob Boyer
Location: InC - 15	
Start Depth: 0 ft. Finish Depth: 6" ft.	
Sample Date: 03/23/ Time: 1410	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

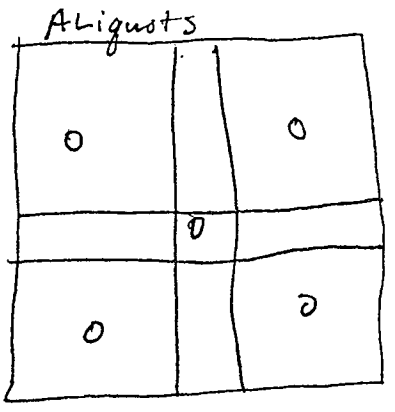
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC- 14-0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-16 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1420	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

QA/QC Information

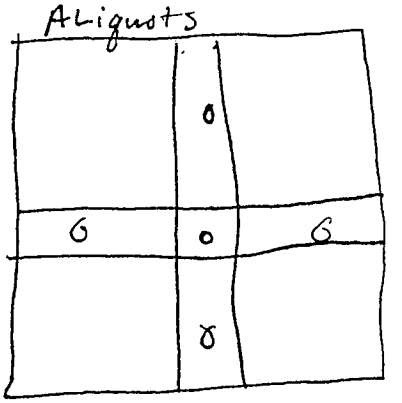
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-16-0006

INC-16-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC -17 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1430	Sampling Personnel: Andy Arnold Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

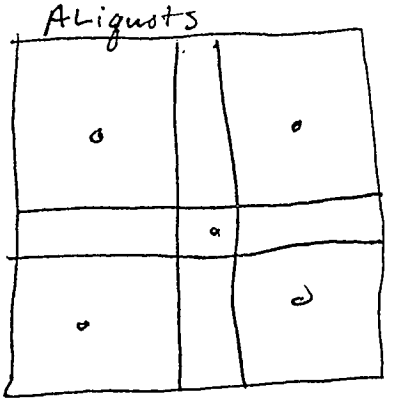
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-17-0006

INC-17-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: InC-18 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1440	Sampling Personnel: Andy Arnold Brett Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

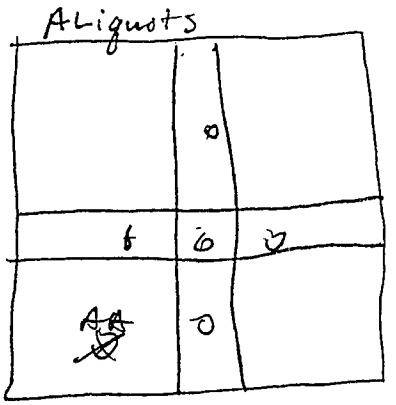
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-18-0006

InC-18-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-19 Start Depth: 0 ft. Finish Depth: 2 ft. Sample Date: 03/23/ Time: 1450	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

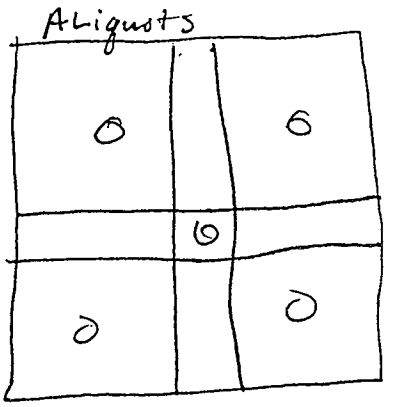
Notes/Sketch Map:

Samples Collected

INC-19-0006

INC-19-0612

INC-19-1224



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-20 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1500	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

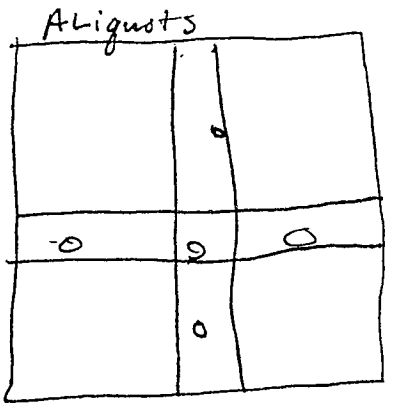
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-20-0006

INC-20-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: Inc -21 Start Depth: 0 ft. Finish Depth: 2 ft. Sample Date: 03/23/ Time: 1570	Sampling Personnel: Andy Arnold Brett Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

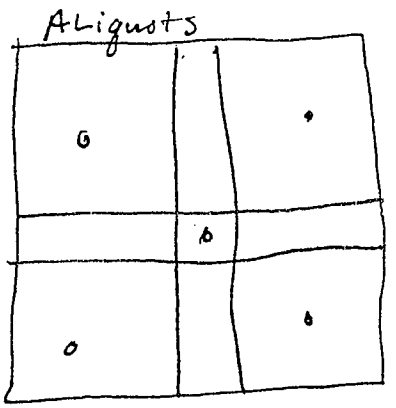
Notes/Sketch Map:

Samples Collected

Inc-21-0006

Inc-21-0662

Inc-21-1224



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold Brad Boyer
Location: INC-22	
Start Depth: 0 ft. Finish Depth: 1 ft.	
Sample Date: 03/23/ Time: 1520	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y
Weather CLR P. CLDY CLDY FOG	
Temp 55 °F Wind Calm Mod High	
Precip Rain Lite Mod High	
Snow Lite Mod High	
Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

QA/QC Information

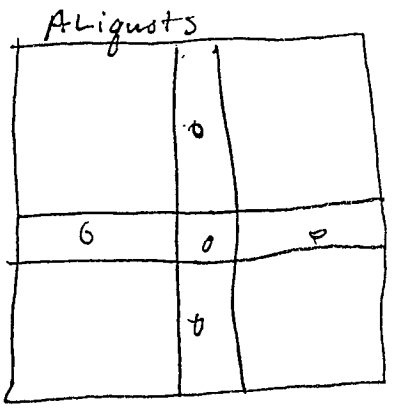
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-22-0006

INC-22-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold Brad Boyer
Location: InC-23 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1530	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

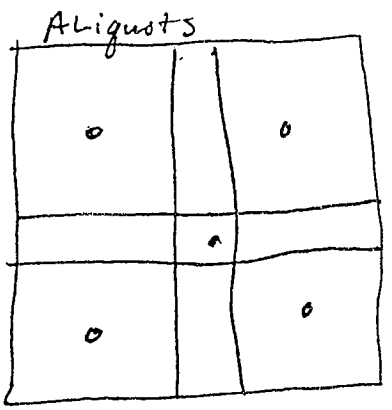
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-23-0006

InC-23-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC 24 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1540	Sampling Personnel: Andy Arnold, Beta Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

QA/QC Information

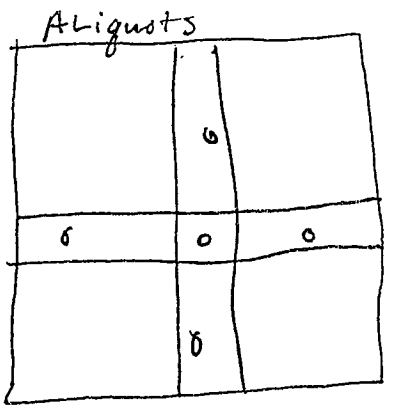
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-24-0006

INC-24-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold Brad Boyer
Location: INC-25	
Start Depth: 0 ft. Finish Depth: 2 ft.	
Sample Date: 03/23/ Time: 1550	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

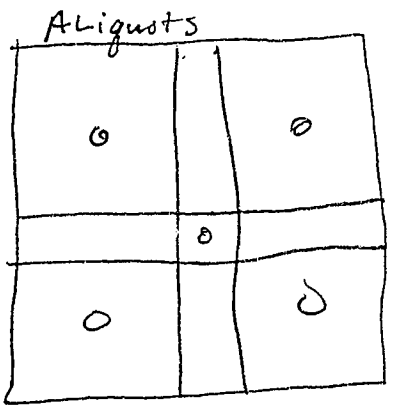
Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected
INC-25-0006
INC-25-0612
INC-24-0224



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-26 Start Depth: 0 ft. Finish Depth: 1 ft. Sample Date: 03/23/ Time: 1600	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: Soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

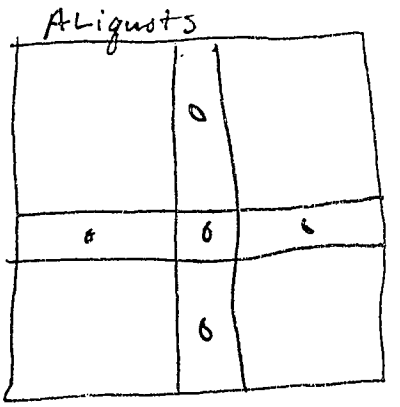
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-26-0006

INC-26-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: Inc	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold, Brad Boyer
Location: Inc-27	
Start Depth: 0 ft. Finish Depth: 6" ft.	
Sample Date: 03/23/ Time: 1610	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y

Weather CLR P. CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Recuired	Method Number	Laboratory
Ziplex Bags				
(guards) size				

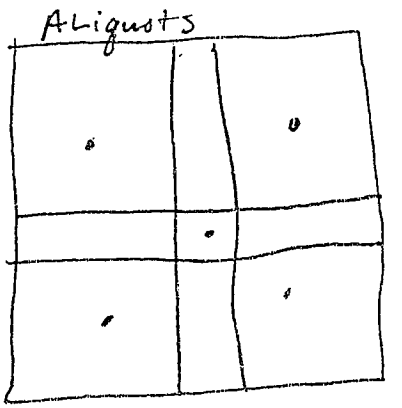
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC-27 0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: INC-28 Start Depth: 0 ft. Finish Depth: 6" ft. Sample Date: 03/23/ Time: 1620	Sampling Personnel: Andy Arnold, Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe	Composite? Y
Weather CLR P.CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags (quarts) size				

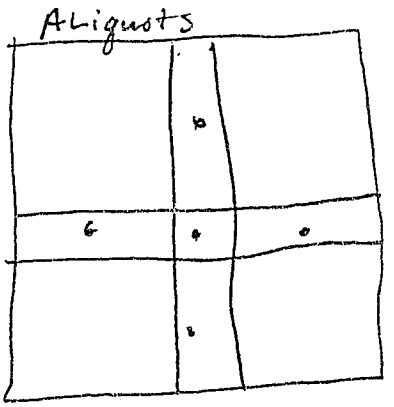
QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

INC28-0006



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION Site: InC	PROJECT NAME : FT. RILEY ARROWHEAD Project Number: 01-224
Sample No.: Type: SO Location: InC29 Start Depth: 0" ft. Finish Depth: 1 ft. Sample Date: 03/23/01 Time: 1630	Sampling Personnel: Andy Arnold Brad Boyer Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: soil probe Composite? Y	
Weather CLR P. CLDY CLDY FOG Temp 55 °F Wind Calm Mod High Precip Rain Lite Mod High Snow Lite Mod High Location Description:	

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

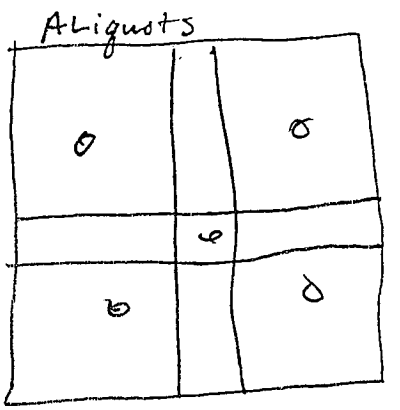
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

InC-29-0006

InC-29-0612



SOIL SAMPLE COLLECTION FIELD SHEET

Project: SOIL CHARACTERIZATION	PROJECT NAME : FT. RILEY
Site: InC	ARROWHEAD Project Number: 01-224
Sample No.: Type: SO	Sampling Personnel: Andy Arnold Bob Boyer
Location: Inc-30	
Start Depth: 0 ft. Finish Depth: 1 ft.	
Sample Date: 03/23/ Time: 1640	Site Manager: SFS
Sample Matrix: Soil ✓ Sample Method: Soil probe	Composite? Y

Weather CLR P.CLDY CLDY FOG
Temp 55 °F Wind Calm Mod High
Precip Rain Lite Mod High
Snow Lite Mod High
Location Description:

Soil Description:

Depth:	Description:

Sampling Information:

Sample Container	Preservative	Analysis Required	Method Number	Laboratory
Ziploc Bags				
(quarts) size				

QA/QC Information

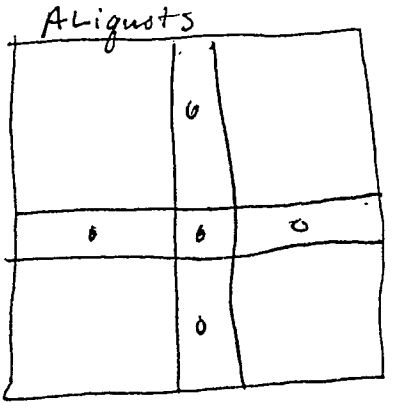
Type	Sample Number	Container	Preservative	Analysis Required	Method Number	Laboratory

Notes/Sketch Map:

Samples Collected

Inc-30-0006

Inc-30-0612



2006 USACE-CENWK Investigation

CENWK-EC-EF 3/12/07

MEMORANDUM FOR: PM-E Van-Saun

SUBJECT: Report for Sampling at Camp Funston Incinerator December 2007

Introduction:

At the request of Fort Riley, environmental sampling was performed at the site of an abandoned incinerator located at Camp Funston on Fort Riley, KS. The Camp Funston Incinerator (CFI) site is a WWI- era facility that mapping indicates was just south of the present Huebner Road and railroad tracks and just west of Threemile Creek. Foundation and slab remnants have been identified at the site. No other information about the site is currently available, including operational practices. The interest, was to determine if areas where residual ash or ash-contaminated soils may be present. The identified foundations comprise an area of approximately 60 by 75 feet; the entire area of interest is estimated to be approximately 75 by 150 feet.

Current installation plans call for the site to remain in non-residential use.

Objective:

To verify results of previous XRF study of the site.

To determine distribution of metals concentrations possibly arising from previous use as an incinerator site.

Sampling:

100 of 108 planned samples for metals by Method 6010 and 6020 were collected from the former Camp Funston Incinerator site. Samples were hand augered to a depth of 24" with samples being taken at 0-6", 6"-12" and 12"-24". Locations 1 and 2 were not taken due to rock being encountered at less than 6" and indications that soil disturbance had occurred during the installation of the railroad line. All other sample locations were collected except the 12"-24" at locations 7 and 15. Several sampling locations were offset during the sampling due to encountering rock. Sampled locations were located using GPS except in those locations where trees made satellite reception problematic. Sampling sites for those locations that could not be located with GPS are approximate. Sampling sites are presented in Figure 1 and GIS coordinates in Table 9. Samples 25 through 30 were taken on the slope of the hill south of the incinerator and samples 31 through 36 were taken at the bottom of the embankment. All sites were marked with pin flags with sample numbers. Samples taken are presented in Table 1. Duplicate samples were taken at four locations as presented in Table 2. Sample numbers 1 and 2 were used to represent duplicates as they were not taken as normal samples.

Results:

Results were compared to Residential Soil RSKs, those samples exceeding the RSK are presented in Table 3.

A comparison of sample results was also made to Non-Residential Soil RSKs. Those samples above this limit are given in Table 4 and Figure 2.

Results of the analysis for all samples and analytes are presented in Table 7.

TCLP extraction of samples from all three depths were taken at locations 9, 14, 16 & 27. Analysis of these samples showed no metals above leaching limits. Results of TCLP analysis are presented in Table 8.

In order to examine the distribution of concentrations in the sampled area, arsenic (As) concentrations above 5 mg/kg (Table 5) and lead (Pb) results greater than 100 mg/kg (Table 6) were used. This does not indicate that these samples are of concern; they are only used to illustrate the extent of possible incinerator activity. Results are presented in Figure 3 and Table 5 and Table 6. The sample locations are approximate in Figures 2 and 3; for more precise locations of samples refer to Figure 1.

Conclusions:

Findings from this study roughly approximate the results from the XRF sampling. As in the XRF, this study indicates that the contamination of the site is concentrated west and south of the incinerator pad.

Arsenic
At INC14, INC15 and INC13 in the XRF study, higher As was indicated southwest and south of the pad. This study confirmed this finding but indicated that higher As levels were wider spread than the XRF. The indications are that As is generally confined to the top 12" of the soil to the west of the pad (Samples 7, 8, 13, 19, 20, 25 and 31) and down to 24" south of the pad (Samples 21, 22, 26, 27, 28, 29, 32, 33 and 34). XRF samples in the area west of the pad (INC5, INC6, INC26, INC25, and INC30) do not indicate higher As, which is indicated in this study. Sensitivity and selectivity of the two methods of analysis may be the reason for this discrepancy.

Lead
The high Pb detection at INC13 was confirmed in samples 26, 27 and 32. All of these samples indicated Pb above RSKs in the soil at the 0-6" level but not below. Lead concentrations above 100 mg/kg but below the RSKs were detected in most of the samples that indicated As at elevated levels. These concentrations did extend below 6". The high Pb detection at location 8 is not congruous with detections at locations surrounding this sample. The high Pb concentration isolated from other Pb detections may indicate that the source of Pb in this sample is spurious and is not indicative of past activities.

Not corroborated was the Pb detection at INC10. Samples in the northeast quadrant of the sampled area are clear of any Pb in excess of 100 mg/kg except for Location 5, which had a detection above 100 but below any RSKs.

Lead concentrations above 100 mg/kg are essentially congruent with arsenic concentrations in excess of 5 mg/kg. Lead at these concentrations is seen in the south and west of the site and extend below 6" as do the arsenic concentrations.

Mercury
Only one sample at location 26 in the 0-6" range had concentrations of mercury above the Residential but not above the Non-Residential RSKs.

Interpretation:

This sampling demonstrates that the results of the XRF sampling are generally representative of the site.

Arsenic and lead levels below the RSKs but above background indicate that any effects of past incinerator activities are limited to the west and south of the site.

Due to the low results for TCLP leaching in these samples there is a low probability that contaminates will leach from the soil to the groundwater at the site.

Table 1: Samples Taken			
Location	0-6	6-12	12-24
CFI06-01			
CFI06-02			
CFI06-03	X	X	X
CFI06-04	X	X	X
CFI06-05	X	X	X
CFI06-06	X	X	X
CFI06-07	X	X	
CFI06-08	X	X	X
CFI06-09	X	X	X
CFI06-10	X	X	X
CFI06-11	X	X	X
CFI06-12	X	X	X
CFI06-13	X	X	X
CFI06-14	X	X	X
CFI06-15	X	X	
CFI06-16	X	X	X
CFI06-17	X	X	X
CFI06-18	X	X	X
CFI06-19	X	X	X
CFI06-20	X	X	X
CFI06-21	X	X	X
CFI06-22	X	X	X
CFI06-23	X	X	X
CFI06-24	X	X	X
CFI06-25	X	X	X
CFI06-26	X	X	X
CFI06-27	X	X	X
CFI06-28	X	X	X
CFI06-29	X	X	X
CFI06-30	X	X	X
CFI06-31	X	X	X
CFI06-32	X	X	X
CFI06-33	X	X	X
CFI06-34	X	X	X
CFI06-35	X	X	X
CFI06-36	X	X	X

Table 2: Duplicate Pairs	
Sample	Duplicate
CFI06-11	CFI06-37
CFI06-16	CFI06-38
CFI06-24	CFI06-02
CFI06-36	CFI06-01

Table 3: Camp Funston Incinerator 2006 Soil Results > Residential Soil RSKs												
Sample ID	Location	Depth	Arsenic			Lead			Mercury		
RSK Residential Soil			11	mg/kg		400	mg/kg		2	mg/kg	
CFI06-07 0-6	07	0-6	64.4	mg/kg							
CFI06-07 6-12	07	6-12	52.4	mg/kg							
CFI06-08 0-6	08	0-6				1300	mg/kg				
CFI06-19 0-6	19	0-6	18.3	mg/kg							
CFI06-20 6-12	20	6-12	11.9	mg/kg							
CFI06-21 0-6	21	0-6	20.9	mg/kg							
CFI06-21 6-12	21	6-12	14.7	mg/kg							
CFI06-21 12-24	21	12-24	14.6	mg/kg							
CFI06-22 6-12	22	6-12	22.2	mg/kg							
CFI06-22 12-24	22	12-24	16.2	mg/kg							
CFI06-26 0-6	26	0-6	16.4	mg/kg		509	mg/kg				
CFI06-26 6-12	26	6-12	20.7	mg/kg					16.5	mg/kg	
CFI06-26 12-24	26	12-24	26.2	mg/kg							
CFI06-27 0-6	27	0-6	47.4	mg/kg		844	mg/kg				
CFI06-27 6-12	27	6-12	37.5	mg/kg							
CFI06-27 12-24	27	12-24	36.2	mg/kg							
CFI06-28 0-6	28	0-6	15.2	mg/kg							
CFI06-28 6-12	28	6-12	16.8	mg/kg							
CFI06-28 12-24	28	12-24	14.3	mg/kg							
CFI06-29 0-6	29	0-6	15.2	mg/kg							
CFI06-29 6-12	29	6-12	25.9	mg/kg							
CFI06-29 12-24	29	12-24	21.1	mg/kg							
CFI06-32 6-12	32	6-12	15.2	mg/kg		439	mg/kg		400	mg/kg	
CFI06-32 12-24	32	12-24	22.3	mg/kg							
CFI06-33 0-6	33	0-6	13.7	mg/kg							
CFI06-33 6-12	33	6-12	11.7	mg/kg							

Table 4: Camp Funston Incinerator 2006 Soil Results > Non-Residential Soil RSKs								
Sample ID	Location	Depth	Arsenic			Lead		
RSK Nonresidential Soil			38	mg/kg		1000	mg/kg	
CFI06-07 0-6	07	0-6	64.4	mg/kg				
CFI06-07 6-12	07	6-12	52.4	mg/kg				
CFI06-08 0-6	08	0-6				1300	mg/kg	
CFI06-27 0-6	27	0-6	47.4	mg/kg				

Table 5: Camp Funston Incinerator 2006 Soil Arsenic Results > 5			
	Depth		
Location	0-6	6-12	12-24
05	6 mg/kg		
07	64.4 mg/kg	52.4 mg/kg	
08	8.75 mg/kg		
09	5.86 mg/kg		
13	9.78 mg/kg		
19	18.3 mg/kg	10.9 mg/kg	
20	9.07 mg/kg	11.9 mg/kg	5.43 mg/kg
21	20.9 mg/kg	14.7 mg/kg	14.6 mg/kg
22		22.2 mg/kg	16.2 mg/kg
25	5.61 mg/kg	5.46 mg/kg	
26	16.4 mg/kg	20.7 mg/kg	26.2 mg/kg
27	47.4 mg/kg	37.5 mg/kg	36.2 mg/kg
28	15.2 mg/kg	16.8 mg/kg	14.3 mg/kg
29	15.2 mg/kg	25.9 mg/kg	21.1 mg/kg
31	7.4 mg/kg	6.69 mg/kg	5.26 mg/kg
32	5.43 mg/kg	15.2 mg/kg	22.3 mg/kg
33	13.7 mg/kg	11.7 mg/kg	8.87 mg/kg
34	6.24 mg/kg		6.54 mg/kg
35		5.4 mg/kg	5.4 mg/kg
36		5.1 mg/kg	5.44 mg/kg

Table 6: Camp Funston Incinerator 2006 Soil Lead Results > 100			
	Depth		
Location	0-6"	6-12"	12-24"
05	220 mg/kg		
07	189 mg/kg		
08	1300 mg/kg		
13	136 mg/kg		
19	187 mg/kg		
20		105 mg/kg	
21	172 mg/kg	115 mg/kg	
22		264 mg/kg	270 mg/kg
26	509 mg/kg	123 mg/kg	362 mg/kg
27	844 mg/kg	277 mg/kg	344 mg/kg
28	220 mg/kg	106 mg/kg	136 mg/kg
29	147 mg/kg	333 mg/kg	143 mg/kg
32		439 mg/kg	400 mg/kg
33	110 mg/kg	107 mg/kg	

Table 7: Camp Funston Incinerator 2006 Soil Results												
Location	Depth	Arsenic		Barium		Cadmium			Chromium			
03	0-6	4.92	mg/kg	138	mg/kg	0.901	mg/kg		5.57	mg/kg		
03	6-12	4.48	mg/kg	93.2	mg/kg	0.158	mg/kg		6.56	mg/kg		
03	12-24	3.28	mg/kg	106	mg/kg	0.0478	mg/kg	J	6.65	mg/kg		
04	0-6	3.65	mg/kg	93.1	mg/kg	0.712	mg/kg		5.57	mg/kg		
04	6-12	3.41	mg/kg	85.4	mg/kg	0.0823	mg/kg		5.74	mg/kg		
04	12-24	2.73	mg/kg	97.3	mg/kg	0.0468	mg/kg	J	5.54	mg/kg		
05	0-6	6	mg/kg	835	mg/kg	0.475	mg/kg		6.02	mg/kg		
05	6-12	3.82	mg/kg	253	mg/kg	0.2	mg/kg		5.76	mg/kg		
05	12-24	2.5	mg/kg	142	mg/kg	0.0858	mg/kg	U	5.69	mg/kg		
06	0-6	2.65	mg/kg	135	mg/kg	0.259	mg/kg		6.99	mg/kg		
06	6-12	2.74	mg/kg	116	mg/kg	0.0668	mg/kg	J	6.86	mg/kg		
06	12-24	3.08	mg/kg	101	mg/kg	0.105	mg/kg	U	6.82	mg/kg		
07	0-6	64.4	mg/kg	206	mg/kg	0.858	mg/kg		5.77	mg/kg		
07	6-12	52.4	mg/kg	120	mg/kg	0.725	mg/kg		5.98	mg/kg		
08	0-6	8.75	mg/kg	268	mg/kg	7.35	mg/kg		25.9	mg/kg		
08	6-12	3.82	mg/kg	103	mg/kg	0.0994	mg/kg	U	6.92	mg/kg		
08	12-24	2.68	mg/kg	99.5	mg/kg	0.0906	mg/kg	U	5.76	mg/kg		
09	0-6	5.86	mg/kg	121	mg/kg	0.331	mg/kg		5.83	mg/kg		
09	6-12	3.78	mg/kg	95	mg/kg	0.119	mg/kg		5.85	mg/kg		
09	12-24	3.33	mg/kg	112	mg/kg	0.283	mg/kg		6.62	mg/kg		
10	0-6	4.28	mg/kg	158	mg/kg	0.287	mg/kg		6.96	mg/kg		
10	6-12	2.96	mg/kg	103	mg/kg	0.155	mg/kg		6.16	mg/kg		
10	12-24	2.89	mg/kg	94.1	mg/kg	0.0913	mg/kg	U	5.75	mg/kg		
11	0-6	2.96	mg/kg	78.3	mg/kg	0.249	mg/kg		5.84	mg/kg		
11	6-12	3.13	mg/kg	91.7	mg/kg	0.0516	mg/kg	J	7.09	mg/kg		
11	12-24	2.76	mg/kg	96.5	mg/kg	0.0537	mg/kg	J	5.7	mg/kg		
12	0-6	4.24	mg/kg	139	mg/kg	0.241	mg/kg		7.25	mg/kg		
12	6-12	2.78	mg/kg	96.9	mg/kg	0.0634	mg/kg	J	7.23	mg/kg		
12	12-24	3.54	mg/kg	87.6	mg/kg	0.0815	mg/kg	U	6.33	mg/kg		
13	0-6	9.78	mg/kg	168	mg/kg	0.559	mg/kg		5.2	mg/kg		
13	6-12	2.96	mg/kg	85.1	mg/kg	0.1	mg/kg	U	5.82	mg/kg		
13	12-24	3.57	mg/kg	107	mg/kg	0.0951	mg/kg	U	7.2	mg/kg		
14	0-6	3.02	mg/kg	101	mg/kg	0.101	mg/kg	U	6.4	mg/kg		
14	6-12	2.93	mg/kg	103	mg/kg	0.11	mg/kg	U	5.89	mg/kg		
14	12-24	3.39	mg/kg	89.7	mg/kg	0.298	mg/kg		5.85	mg/kg		
15	0-6	3.26	mg/kg	144	mg/kg	0.667	mg/kg		6.98	mg/kg		
15	6-12	2.89	mg/kg	86.5	mg/kg	0.337	mg/kg		5.69	mg/kg		
16	0-6	2.74	mg/kg	57.3	mg/kg	0.645	mg/kg		8.93	mg/kg		
16	6-12	3.58	mg/kg	118	mg/kg	0.0952	mg/kg	J	6.51	mg/kg		
16	12-24	3.64	mg/kg	112	mg/kg	0.0829	mg/kg	J	6.48	mg/kg		
17	0-6	4.02	mg/kg	113	mg/kg	0.56	mg/kg		7.86	mg/kg		
17	6-12	4.77	mg/kg	84.4	mg/kg	0.751	mg/kg		13.8	mg/kg		
17	12-24	2.8	mg/kg	95.3	mg/kg	0.113	mg/kg		6.18	mg/kg		
18	0-6	3.08	mg/kg	134	mg/kg	0.316	mg/kg		5.96	mg/kg		
18	6-12	2.98	mg/kg	119	mg/kg	0.187	mg/kg		6.2	mg/kg		

Table 7: Camp Funston Incinerator 2006 Soil Results												
Location	Depth	Arsenic		Barium		Cadmium			Chromium			
18	12-24	3.08	mg/kg	83.6	mg/kg	0.0883	mg/kg	U	6.4	mg/kg		
19	0-6	18.3	mg/kg	296	mg/kg	2.53	mg/kg		6.31	mg/kg		
19,	6-12	10.9	mg/kg	532	mg/kg	0.772	mg/kg		7.06	mg/kg		
19	12-24	4.35	mg/kg	143	mg/kg	0.484	mg/kg		7.81	mg/kg		
20	0-6	9.07	mg/kg	149	mg/kg	2.39	mg/kg		5.71	mg/kg		
20	6-12	11.9	mg/kg	100	mg/kg	4.08	mg/kg		6.56	mg/kg		
20	12-24	5.43	mg/kg	136	mg/kg	0.103	mg/kg	U	7.38	mg/kg		
21	0-6	20.9	mg/kg	309	mg/kg	2.85	mg/kg		6.33	mg/kg		
21	6-12	14.7	mg/kg	1040	mg/kg	2.51	mg/kg		6.82	mg/kg		
21	12-24	14.6	mg/kg	867	mg/kg	3.07	mg/kg		19.3	mg/kg		
22	0-6	3.7	mg/kg	77	mg/kg	1.19	mg/kg		9.83	mg/kg		
22	6-12	22.2	mg/kg	374	mg/kg	2.99	mg/kg		9.01	mg/kg		
22	12-24	16.2	mg/kg	1100	mg/kg	1.72	mg/kg		9.66	mg/kg		
23	0-6	4.85	mg/kg	212	mg/kg	0.632	mg/kg		6.97	mg/kg		
23	6-12	4.95	mg/kg	119	mg/kg	0.488	mg/kg		6.19	mg/kg		
23	12-24	4.94	mg/kg	135	mg/kg	0.379	mg/kg		7.35	mg/kg		
24	0-6	3.8	mg/kg	113	mg/kg	0.504	mg/kg		6.87	mg/kg		
24	6-12	3.2	mg/kg	128	mg/kg	0.204	mg/kg		6.75	mg/kg		
24	12-24	4.46	mg/kg	118	mg/kg	0.137	mg/kg		5.84	mg/kg		
25	0-6	5.61	mg/kg	185	mg/kg	0.725	mg/kg		7.78	mg/kg		
25	6-12	5.46	mg/kg	133	mg/kg	0.398	mg/kg		7.33	mg/kg		
25	12-24	4.41	mg/kg	128	mg/kg	0.269	mg/kg		6.77	mg/kg		
26	0-6	16.4	mg/kg	269	mg/kg	3.66	mg/kg		11.2	mg/kg		
26	6-12	20.7	mg/kg	265	mg/kg	11.7	mg/kg		11.5	mg/kg		
26	12-24	26.2	mg/kg	175	mg/kg	6.25	mg/kg		9.64	mg/kg		
27	0-6	47.4	mg/kg	510	mg/kg	9.57	mg/kg		11.8	mg/kg		
27	6-12	37.5	mg/kg	559	mg/kg	10.8	mg/kg		10.9	mg/kg		
27	12-24	36.2	mg/kg	395	mg/kg	4.98	mg/kg		10	mg/kg		
28	0-6	15.2	mg/kg	614	mg/kg	1.89	mg/kg		9.22	mg/kg		
28	6-12	16.8	mg/kg	640	mg/kg	1.27	mg/kg		8.32	mg/kg		
28	12-24	14.3	mg/kg	406	mg/kg	1.92	mg/kg		11.3	mg/kg		
29	0-6	15.2	mg/kg	359	mg/kg	3	mg/kg		7.87	mg/kg		
29	6-12	25.9	mg/kg	440	mg/kg	4.19	mg/kg		9.01	mg/kg		
29	12-24	21.1	mg/kg	644	mg/kg	1.97	mg/kg		8.05	mg/kg		
30	0-6	2.98	mg/kg	131	mg/kg	0.12	mg/kg		6.53	mg/kg		
30	6-12	3.14	mg/kg	132	mg/kg	0.087	mg/kg	U	7.41	mg/kg		
30	12-24	3.53	mg/kg	123	mg/kg	0.0941	mg/kg	U	7.59	mg/kg		
31	0-6	7.4	mg/kg	182	mg/kg	0.225	mg/kg		10.2	mg/kg		
31	6-12	6.69	mg/kg	169	mg/kg	0.126	mg/kg		9.23	mg/kg		
31	12-24	5.26	mg/kg	158	mg/kg	0.0583	mg/kg	J	9.16	mg/kg		
32	0-6	5.43	mg/kg	173	mg/kg	1.12	mg/kg		10.8	mg/kg		
32	6-12	15.2	mg/kg	277	mg/kg	4.91	mg/kg		11.7	mg/kg		
32	12-24	22.3	mg/kg	311	mg/kg	6.81	mg/kg		12.7	mg/kg		
33	0-6	13.7	mg/kg	188	mg/kg	1.78	mg/kg		8.93	mg/kg		
33	6-12	11.7	mg/kg	266	mg/kg	2.2	mg/kg		10.3	mg/kg		
33	12-24	8.87	mg/kg	191	mg/kg	0.828	mg/kg		9.71	mg/kg		

Table 7: Camp Funston Incinerator 2006 Soil Results													
Location	Depth	Arsenic		Barium		Cadmium			Chromium		
34	0-6	6.24	mg/kg	196	mg/kg	0.253	mg/kg		10.1	mg/kg	
34	6-12	4.56	mg/kg	158	mg/kg	0.085	mg/kg		9.19	mg/kg	
34	12-24	6.54	mg/kg	203	mg/kg	0.0589	mg/kg	J	10.7	mg/kg	
35	0-6	4.66	mg/kg	169	mg/kg	0.192	mg/kg		9.05	mg/kg	
35	6-12	5.4	mg/kg	173	mg/kg	0.0589	mg/kg	J	9.28	mg/kg	
35	12-24	5.4	mg/kg	188	mg/kg	0.179	mg/kg		9.78	mg/kg	
36	0-6	4.25	mg/kg	148	mg/kg	0.111	mg/kg		8.4	mg/kg	
36	6-12	4.98	mg/kg	151	mg/kg	0.0959	mg/kg	U	8.84	mg/kg	
36	12-24	5.44	mg/kg	215	mg/kg	0.0672	mg/kg	J	10	mg/kg	

Table 7: Camp Funston Incinerator 2006 Soil Results													
Location	Depth	Lead		Mercury		Selenium			Silver		
03	0-6	67.8	mg/kg	0.115	mg/kg	0.721	mg/kg	J	0.249	mg/kg	U
03	6-12	23.7	mg/kg	0.07	mg/kg	0.89	mg/kg	U	0.273	mg/kg	U
03	12-24	16	mg/kg	0.016	mg/kg J	1.14	mg/kg	U	0.226	mg/kg	U
04	0-6	48.5	mg/kg	0.422	mg/kg	0.574	mg/kg	J	0.953	mg/kg	
04	6-12	16.2	mg/kg	0.028	mg/kg	0.996	mg/kg	U	0.204	mg/kg	U
04	12-24	13.1	mg/kg	0.014	mg/kg J	0.899	mg/kg	U	0.234	mg/kg	U
05	0-6	220	mg/kg	0.221	mg/kg	0.7	mg/kg	J	0.228	mg/kg	U
05	6-12	23.4	mg/kg	0.042	mg/kg	0.461	mg/kg	J	0.231	mg/kg	U
05	12-24	13.8	mg/kg	0.021	mg/kg	0.762	mg/kg	U	0.214	mg/kg	U
06	0-6	32	mg/kg	0.05	mg/kg	0.601	mg/kg	J	0.281	mg/kg	U
06	6-12	17.6	mg/kg	0.02	mg/kg J	0.958	mg/kg	U	0.267	mg/kg	U
06	12-24	16	mg/kg	0.012	mg/kg J	0.847	mg/kg	U	0.262	mg/kg	U
07	0-6	189	mg/kg	0.129	mg/kg	1.13	mg/kg		0.285	mg/kg	U
07	6-12	70.7	mg/kg	0.504	mg/kg	0.696	mg/kg	J	0.278	mg/kg	U
08	0-6	1300	mg/kg	0.085	mg/kg	0.881	mg/kg	U	0.258	mg/kg	U
08	6-12	16.9	mg/kg	0.165	mg/kg	0.897	mg/kg	U	0.248	mg/kg	U
08	12-24	15.2	mg/kg	0.025	mg/kg	0.963	mg/kg	U	0.227	mg/kg	U
09	0-6	40.9	mg/kg	0.059	mg/kg	0.708	mg/kg	J	0.226	mg/kg	U
09	6-12	19.6	mg/kg	0.054	mg/kg	0.999	mg/kg	U	0.25	mg/kg	U
09	12-24	19.6	mg/kg	0.468	mg/kg	0.486	mg/kg	J	0.213	mg/kg	U
10	0-6	46.3	mg/kg	0.115	mg/kg	0.972	mg/kg	U	0.241	mg/kg	U
10	6-12	16.1	mg/kg	0.02	mg/kg	0.941	mg/kg	U	0.237	mg/kg	U
10	12-24	12.5	mg/kg	0.019	mg/kg U	0.898	mg/kg	U	0.228	mg/kg	U
11	0-6	21.7	mg/kg	0.034	mg/kg	0.984	mg/kg	U	0.261	mg/kg	U
11	6-12	14.6	mg/kg	0.016	mg/kg J	1.05	mg/kg	U	0.218	mg/kg	U
11	12-24	13	mg/kg	0.021	mg/kg	0.849	mg/kg	U	0.268	mg/kg	U
12	0-6	42.5	mg/kg	0.291	mg/kg	1.04	mg/kg	U	0.248	mg/kg	U
12	6-12	15	mg/kg	0.02	mg/kg	1.05	mg/kg	U	0.238	mg/kg	U
12	12-24	15.7	mg/kg	0.025	mg/kg	0.982	mg/kg	U	0.204	mg/kg	U
13	0-6	136	mg/kg	0.101	mg/kg	0.884	mg/kg	J	0.263	mg/kg	U
13	6-12	11.1	mg/kg	0.012	mg/kg J	0.938	mg/kg	U	0.25	mg/kg	U
13	12-24	13.8	mg/kg	0.011	mg/kg J	0.501	mg/kg	J	0.238	mg/kg	U
14	0-6	18	mg/kg	0.141	mg/kg	0.928	mg/kg	U	0.253	mg/kg	U

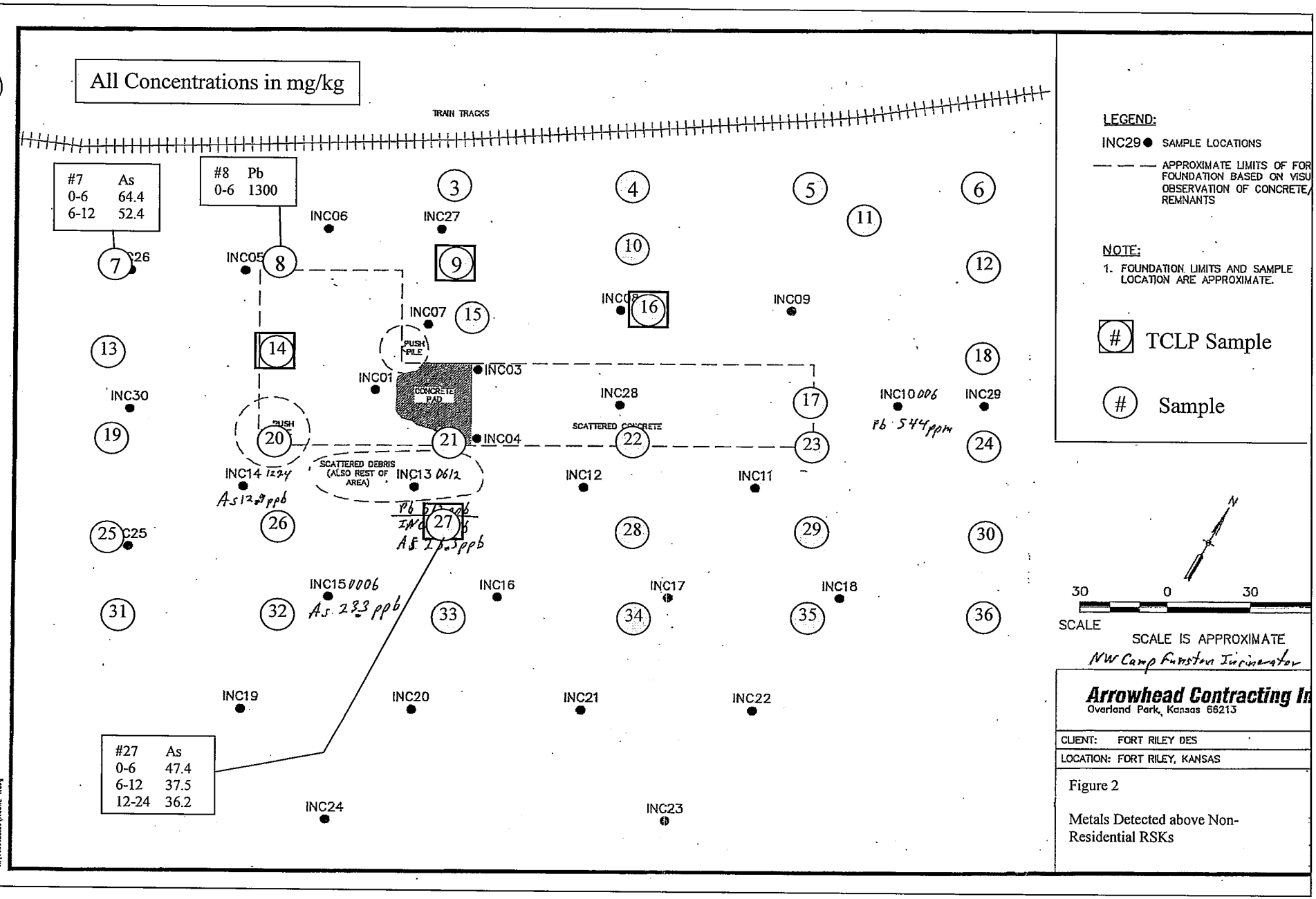
Table 7: Camp Funston Incinerator 2006 Soil Results												
Location	Depth	Lead		Mercury			Selenium			Silver		
14	6-12	15.6	mg/kg	0.117	mg/kg		1	mg/kg	U	0.275	mg/kg	U
14	12-24	24.8	mg/kg	0.093	mg/kg		1.15	mg/kg	U	0.267	mg/kg	U
15	0-6	54.5	mg/kg	0.147	mg/kg		0.75	mg/kg	J	0.299	mg/kg	U
15	6-12	20.9	mg/kg	0.147	mg/kg		0.468	mg/kg	J	0.229	mg/kg	U
16	0-6	30.5	mg/kg	0.08	mg/kg		0.684	mg/kg	J	2.51	mg/kg	
16	6-12	21.2	mg/kg	0.032	mg/kg		1.07	mg/kg	U	0.259	mg/kg	U
16	12-24	19.7	mg/kg	0.021	mg/kg		0.958	mg/kg	U	0.254	mg/kg	U
17	0-6	73.1	mg/kg	0.094	mg/kg		0.522	mg/kg	J	0.23	mg/kg	U
17	6-12	95.4	mg/kg	0.092	mg/kg		0.542	mg/kg	J	0.775	mg/kg	
17	12-24	14.1	mg/kg	0.297	mg/kg		0.383	mg/kg	J	0.222	mg/kg	U
18	0-6	37	mg/kg	0.058	mg/kg		0.581	mg/kg	J	0.229	mg/kg	U
18	6-12	30.9	mg/kg	0.042	mg/kg		0.483	mg/kg	J	0.217	mg/kg	U
18	12-24	13.6	mg/kg	0.018	mg/kg	U	0.869	mg/kg	U	0.221	mg/kg	U
19	0-6	187	mg/kg	0.447	mg/kg		0.948	mg/kg	J	0.215	mg/kg	U
19	6-12	86.5	mg/kg	0.053	mg/kg		0.951	mg/kg		0.212	mg/kg	U
19	12-24	22.5	mg/kg	0.021	mg/kg		0.551	mg/kg	J	0.224	mg/kg	U
20	0-6	72.4	mg/kg	0.112	mg/kg		0.891	mg/kg	J	0.387	mg/kg	U
20	6-12	105	mg/kg	0.076	mg/kg		0.752	mg/kg	J	0.266	mg/kg	U
20	12-24	19.2	mg/kg	0.024	mg/kg		0.504	mg/kg	J	0.257	mg/kg	U
21	0-6	172	mg/kg	0.082	mg/kg		0.785	mg/kg	J	0.197	mg/kg	U
21	6-12	115	mg/kg	0.062	mg/kg		0.872	mg/kg	J	0.215	mg/kg	U
21	12-24	96.5	mg/kg	0.044	mg/kg		0.981	mg/kg	J	0.231	mg/kg	U
22	0-6	63.5	mg/kg	0.128	mg/kg		0.623	mg/kg	J	2.85	mg/kg	
22	6-12	264	mg/kg	0.078	mg/kg		1.07	mg/kg		0.219	mg/kg	U
22	12-24	270	mg/kg	0.06	mg/kg		0.686	mg/kg	J	0.244	mg/kg	U
23	0-6	55	mg/kg	0.151	mg/kg		0.487	mg/kg	J	0.227	mg/kg	U
23	6-12	40.8	mg/kg	0.07	mg/kg		0.859	mg/kg	U	0.232	mg/kg	U
23	12-24	37.8	mg/kg	0.035	mg/kg		0.83	mg/kg	U	0.247	mg/kg	U
24	0-6	39.2	mg/kg	0.046	mg/kg		0.556	mg/kg	J	0.252	mg/kg	U
24	6-12	22.1	mg/kg	0.025	mg/kg		1.01	mg/kg	U	0.242	mg/kg	U
24	12-24	26.4	mg/kg	0.028	mg/kg		0.919	mg/kg	U	0.251	mg/kg	U
25	0-6	47.8	mg/kg	0.057	mg/kg		0.884	mg/kg	J	0.238	mg/kg	U
25	6-12	33.7	mg/kg	0.041	mg/kg		0.645	mg/kg	J	0.212	mg/kg	U
25	12-24	22.1	mg/kg	0.023	mg/kg		0.659	mg/kg	J	0.255	mg/kg	U
26	0-6	509	mg/kg	0.238	mg/kg		0.99	mg/kg		0.221	mg/kg	U
26	6-12	123	mg/kg	16.5	mg/kg		1.31	mg/kg		0.242	mg/kg	U
26	12-24	362	mg/kg	0.024	mg/kg		1.01	mg/kg		0.21	mg/kg	U
27	0-6	844	mg/kg	0.073	mg/kg		1.35	mg/kg		0.234	mg/kg	U
27	6-12	277	mg/kg	0.057	mg/kg		1.34	mg/kg		0.23	mg/kg	U
27	12-24	344	mg/kg	0.048	mg/kg		1.63	mg/kg		0.22	mg/kg	U
28	0-6	220	mg/kg	0.079	mg/kg		0.868	mg/kg	J	0.278	mg/kg	U
28	6-12	106	mg/kg	0.058	mg/kg		1.06	mg/kg		0.19	mg/kg	U
28	12-24	136	mg/kg	0.037	mg/kg		0.879	mg/kg	J	0.239	mg/kg	U
29	0-6	147	mg/kg	0.064	mg/kg		0.935	mg/kg	J	0.252	mg/kg	U
29	6-12	333	mg/kg	0.075	mg/kg		1.06	mg/kg		0.243	mg/kg	U
29	12-24	143	mg/kg	0.077	mg/kg		0.888	mg/kg	J	0.278	mg/kg	U

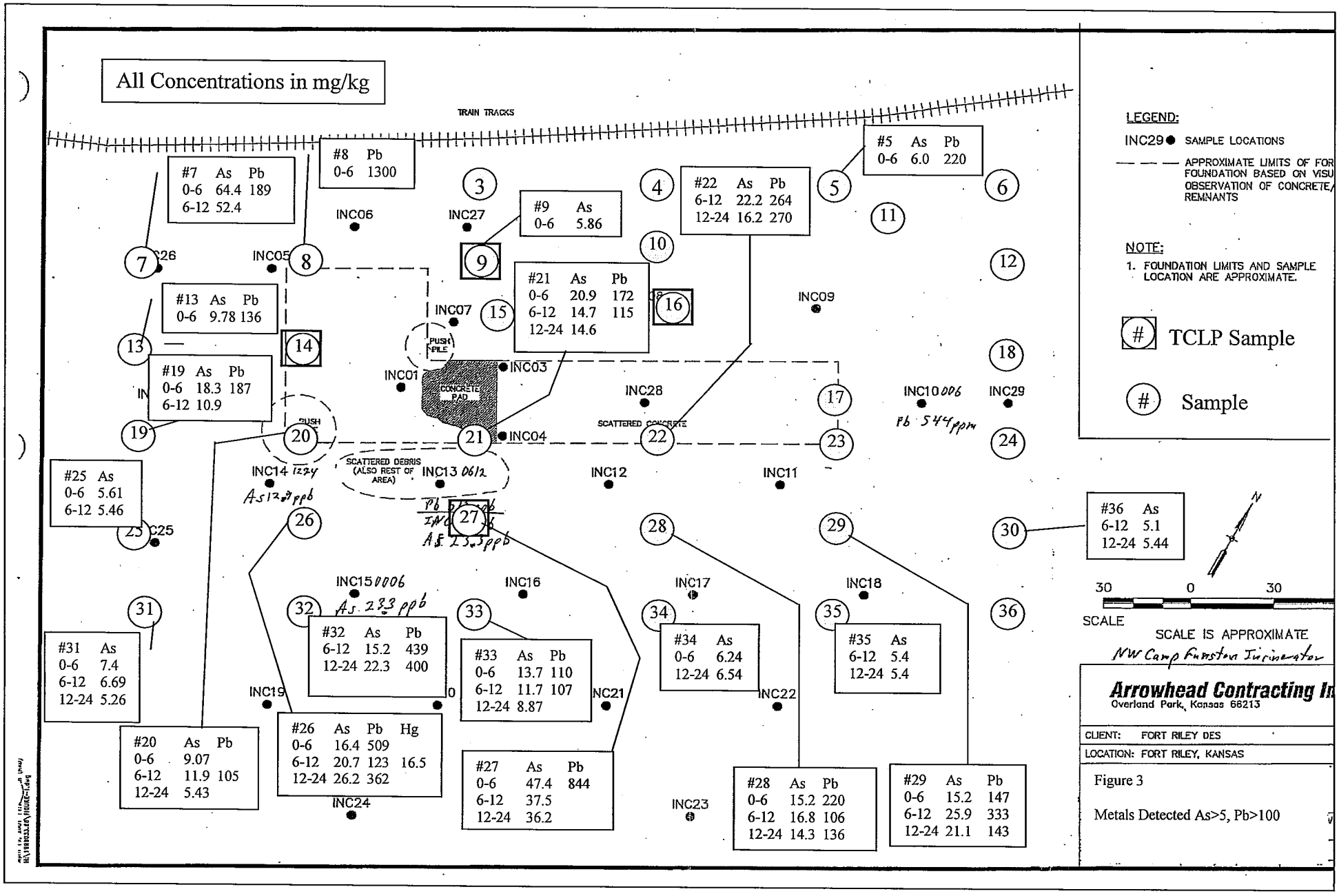
Table 7: Camp Funston Incinerator 2006 Soil Results													
Location	Depth	Lead			Mercury			Selenium			Silver		
30	0-6	26.6	mg/kg		0.034	mg/kg		0.517	mg/kg	J	0.253	mg/kg	U
30	6-12	18.4	mg/kg		0.015	mg/kg	J	0.962	mg/kg	U	0.218	mg/kg	U
30	12-24	15.6	mg/kg		0.014	mg/kg	J	1	mg/kg	U	0.235	mg/kg	U
31	0-6	25.7	mg/kg		0.026	mg/kg		0.619	mg/kg	J	0.26	mg/kg	U
31	6-12	22.7	mg/kg		0.02	mg/kg	J	0.595	mg/kg	J	0.244	mg/kg	U
31	12-24	22.4	mg/kg		0.019	mg/kg	J	0.482	mg/kg	J	0.255	mg/kg	U
32	0-6	91.8	mg/kg		0.037	mg/kg		0.775	mg/kg	J	0.269	mg/kg	U
32	6-12	439	mg/kg		0.059	mg/kg		0.627	mg/kg	J	0.238	mg/kg	U
32	12-24	400	mg/kg		0.041	mg/kg		0.796	mg/kg	J	0.254	mg/kg	U
33	0-6	110	mg/kg		0.093	mg/kg		1.07	mg/kg		0.219	mg/kg	U
33	6-12	107	mg/kg		0.224	mg/kg		0.87	mg/kg	J	0.247	mg/kg	U
33	12-24	52.8	mg/kg		0.035	mg/kg		0.908	mg/kg		0.242	mg/kg	U
34	0-6	26.7	mg/kg		0.035	mg/kg		0.777	mg/kg	J	0.271	mg/kg	U
34	6-12	21.3	mg/kg		0.022	mg/kg		0.532	mg/kg	J	0.208	mg/kg	U
34	12-24	26.5	mg/kg		0.03	mg/kg		0.665	mg/kg	J	0.257	mg/kg	U
35	0-6	24.2	mg/kg		0.035	mg/kg		0.715	mg/kg	J	0.239	mg/kg	U
35	6-12	22.6	mg/kg		0.025	mg/kg		0.613	mg/kg	J	0.232	mg/kg	U
35	12-24	33.3	mg/kg		0.029	mg/kg		0.588	mg/kg	J	0.258	mg/kg	U
36	0-6	22.6	mg/kg		0.034	mg/kg		0.759	mg/kg	J	0.236	mg/kg	U
36	6-12	20.5	mg/kg		0.021	mg/kg		0.959	mg/kg	U	0.24	mg/kg	U
36	12-24	23.5	mg/kg		0.03	mg/kg		0.635	mg/kg	J	0.271	mg/kg	U

Table 8: Camp Funston Incinerator 2006 TCLP Results													
Location	Depth	Arsenic			Barium			Cadmium			Chromium		
9	0-6	0.0327	mg/L		0.575	mg/L		0.004	mg/L	U	0.004	mg/L	U
9	6-12	0.0286	mg/L	J	0.39	mg/L		0.004	mg/L	U	0.004	mg/L	U
9	12-24	0.032	mg/L		0.423	mg/L		0.004	mg/L	U	0.004	mg/L	U
14	0-6	0.0228	mg/L	J	0.751	mg/L		0.004	mg/L	U	0.004	mg/L	U
14	6-12	0.041	mg/L		0.777	mg/L		0.004	mg/L	U	0.004	mg/L	U
14	12-24	0.0349	mg/L		0.588	mg/L		0.004	mg/L	U	0.004	mg/L	U
16	0-6	0.0246	mg/L	J	0.475	mg/L		0.004	mg/L	U	0.004	mg/L	U
16	6-12	0.037	mg/L		0.944	mg/L		0.004	mg/L	U	0.004	mg/L	U
16	12-24	0.0345	mg/L		1.05	mg/L		0.004	mg/L	U	0.004	mg/L	U
27	0-6	0.0767	mg/L		0.802	mg/L		0.0114	mg/L		0.004	mg/L	U
27	6-12	0.0499	mg/L		0.873	mg/L		0.00823	mg/L		0.004	mg/L	U
27	12-24	0.0385	mg/L		0.787	mg/L		0.0126	mg/L		0.004	mg/L	U

Table 8: Camp Funston Incinerator 2006 TCLP Results													
Location	Depth	Lead			Mercury			Selenium			Silver		
9	0-6	0.02	mg/L	U	0.128	ug/L	J	0.03	mg/L	U	0.01	mg/L	U
9	6-12	0.02	mg/L	U	0.2	ug/L	U	0.03	mg/L	U	0.01	mg/L	U
9	12-24	0.02	mg/L	U	0.21	ug/L		0.03	mg/L	U	0.00608	mg/L	J
14	0-6	0.02	mg/L	U	0.146	ug/L	J	0.03	mg/L	U	0.01	mg/L	U
14	6-12	0.02	mg/L	U	0.2	ug/L	U	0.03	mg/L	U	0.01	mg/L	U
14	12-24	0.02	mg/L	U	0.109	ug/L	J	0.03	mg/L	U	0.01	mg/L	U
16	0-6	0.02	mg/L	U	0.2	ug/L	U	0.03	mg/L	U	0.01	mg/L	U
16	6-12	0.02	mg/L	U	0.2	ug/L	U	0.03	mg/L	U	0.01	mg/L	U
16	12-24	0.02	mg/L	U	0.2	ug/L	U	0.03	mg/L	U	0.01	mg/L	U
27	0-6	0.0767	mg/L		0.132	ug/L	J	0.03	mg/L	U	0.01	mg/L	U
27	6-12	0.02	mg/L	U	0.109	ug/L	J	0.03	mg/L	U	0.01	mg/L	U
27	12-24	0.0242	mg/L		0.111	ug/L	J	0.03	mg/L	U	0.01	mg/L	U

Table 9: Camp Funston Incinerator 2006 GPS Coordinates		
Location	Easting	Northing
3	175949.566	4334143.315
4	175963.650	4334150.396
5	175979.042	4334155.155
6	175997.197	4334164.825
12	175999.221	4334158.336
11	175988.546	4334156.757
10	175967.726	4334146.027
16	175968.973	4334143.815
15	175956.159	4334133.504
9	175953.420	4334136.645
8	175933.370	4334124.702
14	175936.071	4334118.296
13	175922.675	4334112.042
7	175919.243	4334117.517
19	175927.639	4334105.508
20	175940.996	4334112.770
21	175958.839	4334120.636
22	175974.979	4334126.674
23	175989.435	4334137.407
24	176006.277	4334144.617
18	176003.728	4334149.282
17	175989.856	4334142.448
25	175931.483	4334099.334


All Concentrations in mg/kg
TRAIN TRACKS
#7 As
0-6 64.4
6-12 52.4
#8 Pb
0-6 1300
INC06
INC27
INC05
INC07
INC08
INC09
PUSH PILE
INC01
INC03
CONCRETE PAD
INC28
INC10 0006
Pb 544ppm
INC29
INC30
PUSH
SCATTERED CONCRETE
INC04
SCATTERED DEBRIS (ALSO REST OF AREA)
INC14 1224
As 12.9 ppb
INC13 0612
INC12
INC11
INC15 0006
As 283 ppb
INC16
INC17
INC18
INC19
INC20
INC21
INC22
INC24
INC23
#27 As
0-6 47.4
6-12 37.5
12-24 36.2
LEGEND:
INC29 SAMPLE LOCATIONS
APPROXIMATE LIMITS OF FOR FOUNDATION BASED ON VISU OBSERVATION OF CONCRETE/ REMNANTS
NOTE:
1. FOUNDATION LIMITS AND SAMPLE LOCATION ARE APPROXIMATE.
TCLP Sample
Sample
30 0 30
SCALE
SCALE IS APPROXIMATE
NW Camp Funston Incinerator
Arrowhead Contracting In
Overland Park, Kansas 66213
CLIENT: FORT RILEY DES
LOCATION: FORT RILEY, KANSAS
Figure 2
Metals Detected above Non-Residential RSKs


All Concentrations in mg/kg
TRAIN TRACKS
#7 As Pb
0-6 64.4 189
6-12 52.4
#8 Pb
0-6 1300
#9 As
0-6 5.86
#5 As Pb
0-6 6.0 220
#22 As Pb
6-12 22.2 264
12-24 16.2 270
#21 As Pb
0-6 20.9 172
6-12 14.7 115
12-24 14.6
#13 As Pb
0-6 9.78 136
#19 As Pb
0-6 18.3 187
6-12 10.9
#25 As
0-6 5.61
6-12 5.46
#31 As
0-6 7.4
6-12 6.69
12-24 5.26
#20 As Pb
0-6 9.07
6-12 11.9 105
12-24 5.43
#32 As Pb
6-12 15.2 439
12-24 22.3 400
#26 As Pb Hg
0-6 16.4 509
6-12 20.7 123 16.5
12-24 26.2 362
#33 As Pb
0-6 13.7 110
6-12 11.7 107
12-24 8.87
#27 As Pb
0-6 47.4 844
6-12 37.5
12-24 36.2
#34 As
0-6 6.24
12-24 6.54
#28 As Pb
0-6 15.2 220
6-12 16.8 106
12-24 14.3 136
#35 As
6-12 5.4
12-24 5.4
#29 As Pb
0-6 15.2 147
6-12 25.9 333
12-24 21.1 143
#36 As
6-12 5.1
12-24 5.44
INC06
INC27
INC05
INC07
INC01
INC03
INC28
INC09
INC10 0.06
INC29
Pb 544ppm
INC14 12.4
As 12.8 ppb
INC13 0.6/2
INC12
INC11
INC15 0.006
As 23.3 ppb
INC16
INC17
INC18
INC19
INC21
INC22
INC24
INC23
CONCRETE PAD
PUSH PILE
SCATTERED DEBRIS (ALSO REST OF AREA)
SCATTERED CONCRETE
LEGEND:
INC29 SAMPLE LOCATIONS
APPROXIMATE LIMITS OF FOR FOUNDATION BASED ON VISU OBSERVATION OF CONCRETE/ REMNANTS
NOTE:
1. FOUNDATION LIMITS AND SAMPLE LOCATION ARE APPROXIMATE.
TCLP Sample
Sample
30 0 30
SCALE
SCALE IS APPROXIMATE
NW Camp Funston Incinerator
Arrowhead Contracting In
Overland Park, Kansas 66213
CLIENT: FORT RILEY DES
LOCATION: FORT RILEY, KANSAS
Figure 3
Metals Detected As>5, Pb>100

2010 CTI & Associates Investigation

CTI and Associates, Inc.

Date: **12 October 2010**

From: **Rob Stenson – CTI and Associates, Inc.**

To: **Rick Van Saun – USACE Kansas City District**
John Shimp – Ft. Riley, Kansas

Copy: **Chris Winkeljohn – CTI and Associates, Inc.**
File

Subject: **Camp Funston WWI Incinerator (CFI) Remediation – Ft. Riley, KS**

This Technical Memorandum has been prepared to summarize field investigation and soil remediation activities performed by CTI & Associates, Inc. (CTI) at the Camp Funston WWI Incinerator (CFI), Fort Riley, Kansas. In addition to the summaries, CTI is also providing a brief alternative analysis for addressing the results from the field investigation activities.

Introduction

The on-site field activities were performed between September 27 and October 6, 2010 to remove arsenic and lead contaminated soil associated with incinerator operation and disposal of ash and cinders along the Kansas River floodplain slope. The field activities were initiated under Scope of Work, Soil Removal Services (Revised May 6, 2010) and Modification 001. The location of the CFI project is presented on Figure 1.

Prior to removal of the CFI ash present along the floodplain slope, a preliminary test pit excavation was performed to evaluate the type of waste material present and to plan the impacted soil removal activities. The preliminary test pit excavation identified up to eight feet of ash and cinders on the floodplain slope with a thin layer of ash and cinders extending beyond the base of the slope within the floodplain sediments. Based on the unknown thickness and horizontal extent of the CFI ash disposal area, USACE-KCD, Fort Riley, and CTI determined further test trench excavations were necessary to define the horizontal and vertical extent of the ash and to collect representative soil and ash/cinder analytical laboratory samples to characterize the CFI ash disposal area.

Field activities included the following:

- Installation of the Threemile Creek low-water crossing to access the CFI site,
- Clearing, grubbing, and disposal of vegetation at the Fort Riley Campbell Hill Tree Disposal Area,
- Arsenic field screen testing and analytical laboratory testing of the railroad spur soil piles to evaluate disposal options,
- Load out and transportation of the clean rail spur soils to the Fort Riley Campbell Hill Construction Debris Landfill to allow adequate access and work area for the investigation,

- Excavation of eight test trenches to delineate the horizontal and vertical extent of the CFI ash deposit, preparation of ash deposit cross-sectional maps, and collection of representative soil and ash/cinder samples to characterization the CFI ash disposal area,
- Backfilling and grading of the test trench area following inspection and sampling,
- Demolition, removal, and off-site disposal of the incinerator foundation and contaminated upland surface soils as special waste at the Waste Management Rolling Meadows Landfill,
- Confirmation soil sampling of the upland area and incinerator foundation to confirm soil removal meets KDHE RSK Tier 2 Risk-Based criteria for residential land use, and
- Installation of silt fencing and planting of winter wheat to minimize erosion in the CFI upland, floodplain slope, and floodplain.

This Technical Memorandum includes a summary of the CFI field investigation and construction methods, description of test trench activities, analytical samples collected and test results, delineation of the horizontal and vertical extent of the ash deposit based on visual inspection, estimates of the CFI ash deposit volume, and recommendations regarding future site remedial options.

Camp Funston Incinerator Investigation Summary

The objectives for the CFI ash disposal area investigation were to delineate the horizontal and vertical extent of the CFI ash disposal area, prepare cross-sectional maps of the ash deposit based on visual inspection during the trench excavations, collect representative soil and ash/cinder samples to characterize the CFI ash for disposal, and develop estimated soil and ash deposit volumes to provide viable remedial options to USACE-KCD and Fort Riley.

To accurately locate the test trench excavations, soil and ash/cinder sample locations, and the physical dimensions of the former incinerator, CTI established a southwest/northeast trending site-specific coordinate system based on the two power poles located within the work area. The power pole to the southwest was established as the grid origin (designated 0, 0). The coordinate system is referenced to latitude and longitude by hand held GPS. Local permanent features, test trench beginning and end, and the test trench sample locations were direct measured from the site coordinate system base line. Local permanent features were also located by GPS including the railroad spur and the railroad spur bridge. The coordinate system and permanent features in the CFI work area, the footprint of the incinerator (based on measurements following exposure during soil removal), and test trench locations are presented on Figure 2.

The topography in the CFI investigation area includes the relatively flat upland area between the railroad siding and the edge of the floodplain, ranging in width from 60 feet in the southwest to 130 feet in the northeast. The floodplain slope is approximately a 3 to 1 slope, 16 feet in height, and extending approximately 50 feet laterally before transitioning to the relatively flat floodplain bottom. Threemile Creek is located approximately 100 feet east of the CFI investigation area and flows within an incised stream channel on the Kansas River Floodplain.

CTI completed eight test trenches to delineate the thickness and horizontal extent of the CFI ash disposal area as shown on Figure 2. The test trench excavations were completed with a Caterpillar 324 excavator with a 4-foot wide bucket. Due to steep slopes and access, the trenches were excavated from both the top of the floodplain slope and bottom of slope with the excavation spoils placed adjacent to the trench. To accurately locate the trench depth, ash thickness, and sample locations, survey lath was placed at the start of the trench (top of slope) and a survey tape placed along the

ground surface to establish distances along the trench length. The survey lath was direct measured to the site specific coordinate system and both the start and the end of the test trench were established by GPS coordinates to determine the orientation of the trench with respect to the coordinate system.

The preliminary test pit to observe site conditions was completed at test trench location TP-4. Based on the observed thickness of ash and cinders encountered, the decision was made to define the full extent of the CFI ash deposit prior to making final decisions regarding how to remediate the ash disposal area. The initial test pit extended down to the floodplain to fully define the horizontal and vertical extent of ash along the TP-4 transect. The remaining test trenches were completed from northeast to southwest.

Prior to the start of the test trench excavations, an access ramp on the floodplain slope was constructed for excavator and skid steer access. Tree and brush clearing was completed along the top of the slope and on the floodplain to provide unimpeded access to the work area. Test trenches TP-0 (northeast ash limit) and TP-7 (southwest ash limit) were completed to define the horizontal extent of the CFI ash disposal area and were completed in the upper reaches on the floodplain slope. Ash and cinders were not visible in these trenches.

The floodplain slope ash thickness in test trenches TP-1 and TP-2 typically ranged from two to three feet, four to six feet in test trenches TP-3 and TP-4, and attaining a maximum thickness of approximately 8 feet in test trench TP-5. To the southwest of TP-5, ash thickness along the floodplain side slope decreased to three to five feet in test trench TP-6 and was not encountered in test trench TP-7. The ash deposit in this area is typically granular, containing ash, cinders, small metallic debris, and occasional glass bottles and other debris as well as layers of finer grained ash and soil. Organic matter, such as, wood, cloth, rubber, etc. were not encountered during the excavations. Figure 3 presents photographs of the typical ash deposits within test trenches TP-4, TP-5, and TP-6. The test trench field logs (TP-1 through TP-6) are presented in Attachment A.

The majority of the CFI ash deposit is located along the floodplain slope and is typically covered by a layer of soil and organic matter ranging in thickness from several inches to over one foot. Toward the toe of the slope and within the level floodplain, the ash deposit is covered by either floodplain sediment or dust bowl silt deposits typically at distance of approximately 50 feet along each test trench excavation. The ash deposits within the floodplain tends to thin to less than a foot in thickness, is finer grained with less granular cinders, and becomes visibly indistinguishable from the fine grained silt and clay floodplain soils. A thin ash layer was commonly encountered at a depth of approximately three feet below grade at distances of 55 to 80 feet along the trench length. Figure 4 presents photographs of a granular ash layer and fine grained red ash at a depth of approximately three feet at a distance of 65 feet.

Following excavation of the test trenches and delineation of the ash deposit thickness and horizontal extent, an ash and soil sampling strategy was developed to characterize the ash disposal area and the overlying and underlying in-place soils. The general sampling strategy for each test trench included the following:

- Collect a composite sample of ash/cinder comprised of several subsamples collected along the length of the test trench. The intent of these samples was to characterize the material either for off-site disposal as special waste or to cap the ash deposit as an institutional control. Laboratory analysis: 8 RCRA Metals and Toxicity Characteristic Leaching Procedure (TCLP).

- Collect a grab sample of the soil underlying the floodplain slope ash deposit to evaluate potential for leaching of metals from the ash deposit. Laboratory analysis: 8 RCRA Metals.
- Collect a grab sample of ash or ash/cinder layer present at a depth within the floodplain sediments (typically at a depth greater than two feet below the floodplain sediments) to characterize the thin ash layers with the intent this material would not be remover for off-site disposal and would remain in-place with the natural soil cover. Laboratory analysis: 8 RCRA Metals and TCLP.
- Collect a grab sample of the soil overlying the floodplain ash deposit to evaluate potential for metals contamination as a result of erosion of the floodplain slope and integration of metals contaminants in the floodplain deposits. Laboratory analysis: 8 RCRA Metals.

The test trench characterization samples were collected by hand using a garden trowel in the shallow portions of the trenches with direct access. In the deeper sections of the trenches, samples were collected with the garden trowel mounted on a 2-inch PVC pipe to allow the sampling of the trench sidewalls from outside the excavation. Characterization samples were placed into ziplock bags and labeled with test trench number, distance along the transect line, sample depth, and a brief description of the material. The sample location and depth was also recorded on the field test trench log. Characterization samples were then transferred to a stainless steel composite bowl and thoroughly mixed prior to placing the sample into the analytical laboratory glassware. The remaining sample was returned to the Ziploc bag and stored for future use, if needed. During the soil sampling process, the thickness of the ash/cinder layers and overlying soil thickness was also direct measured and recorded on the field test trench log. Photographs of the trench sidewalls were also taken during the sampling effort. A summary of the analytical laboratory samples collected during the investigation is presented in Table 1.

The analytical laboratory results identify arsenic as the only constituent exceeding the KDHE – RSK residential criteria in samples collected during the investigation. The composite sample of ash and cinder collected from each of the six test trenches exceeded the KDHE – RSK residential criteria for arsenic (11 mg/kg), ranging from 16.2 mg/kg to 34.4 mg/kg. Individual grab samples of ash collected from thin layers within the floodplain sediments were below the KDHE – RSK residential criteria for arsenic in test trenches TP-1 (6.4 mg/kg) and TP-3 (10.7 mg/kg), and exceeded the KDHE – RSK residential criteria for arsenic in test trenches TP-4 (86.9 mg/kg), TP-5 (21.8 mg/kg), and TP-6 (26.8 mg/kg).

Individual grab samples of soil above the ash layers within the floodplain sediments were below the KDHE – RSK residential criteria for arsenic indicating the transport of contaminants by erosion following the decommissioning of the incinerator has not occurred. Individual grab samples of soil below the ash were below the KDHE – RSK residential criteria for arsenic indicating the contaminants are not mobilized by the infiltration of precipitation. The TCLP analytical laboratory results for the composite ash samples do not exceed the regulatory limits for metals. A summary of the analytical laboratory sample results is presented in Table 2. The laboratory analytical results in hard copy are presented in Attachment B.

Upon completion of the characterization sampling, the test trenches were backfilled using the excavator and a skid steer and the area final graded. In the upland area north of the floodplain slope, the previously identified incinerator concrete slab and suspected incinerator burn area (brick construction) and the associated footings were removed and transported off-site for disposal as special waste. The western most soil pile remaining from the railroad siding contractor, located beneath the

power pole with guy wire exceeded the KDHE – RSK residential criteria for arsenic. This material was placed along the floodplain side slope within the incinerator ash disposal area rather than loading and transporting the material off-site for disposal.

The upland area was then excavated an additional 6 to 12–inches to remove surface soils and debris. This material was transported off-site for disposal as special waste. A total of five confirmation samples comprised of four subsamples each were collected south of the power pole coordinate system base line. Each confirmation grid was approximately 50 in length along the base line and extends from the base line to the edge of the floodplain slope. A sixth confirmation sample comprised of six subsamples was collected within the footprint of the incinerator concrete slab following demolition and removal of the slab footings. The analytical laboratory results for upland confirmation samples are presented in Table 3 and indicate soil metals concentrations below the KDHE – RSK residential criteria. The location of the upland confirmation grids is presented on Figure 5.

The analytical laboratory results for the railroad spur soil pile confirmation samples are presented in Table 3 and indicate the soil piles located northeast of the power pole were below the KDHE – RSK residential criteria. This soil was loaded and transported to the Fort Riley Campbell Hill Construction Debris Landfill. The soil pile located southwest of the power pole exceeded the KDHE – RSK residential criteria and were placed on the floodplain slope within the ash disposal area. The laboratory analytical results in hard copy are presented in Attachment B.

To minimize erosion in the work area, four sections of silt fence were installed as follows: along the railroad siding; top of floodplain slope; bottom of floodplain slope; and outer edge of the disturbed floodplain area. Winter wheat was also planted in the disturbed area and covered with straw to minimize erosion.

Incinerator Ash Deposit Summary

The CFI ash deposit encompasses an area of approximately 16,250 square feet, extending approximately 250 feet southwest to northeast along the floodplain slope and between 50 to 80 feet into the floodplain from the top of the floodplain slope. The aerial extent of the CFI ash deposit, based on visual inspection is presented on Figure 6 and includes approximately 2,580 cubic yards of material. The extent of the ash disposal area is well defined along the floodplain slope based on ash and cinders not being present in test trenches TP-0 and TP-7. Visual delineation of the ash deposit to the south in the floodplain area is not as well defined as the upland area for the following reasons:

- With increasing distance from the primary ash disposal area on the floodplain slope the ash layers tend to thin out or appear to end abruptly;
- The ash becomes finer grained with increased distance from the primary ash disposal area as would be expected if the material was transported by precipitation run-off or wind erosion. Within the floodplain deposits, the ash becomes indistinguishable from the floodplain soils; and,
- Depth of ash layer burial tends to increase, presumably following the topography present at the time the incinerator was operating.

As presented on Figure 6, the ash deposit has been subdivided into the following categories:

- Upland Slope Ash Deposit: Approximately 90 percent of the ash deposit (2,390 cy) is present along the upland slope and is covered by several inches to greater than a foot of soil

and organic matter. This area covers approximately 12,000 square feet with ash thickness ranging from 1 to 8 feet;

- Floodplain Ash Deposit: Based on visual observation, the floodplain ash deposit encompasses approximately 190 cy of ash material. This assumes the ash layer extends 260 feet along the base of the floodplain slope in a band 20 feet wide and one foot thick. The floodplain ash deposit was delineated during the investigation by termination of flat lying floodplain sediments along the floodplain slope. Floodplain sediments overlying the ash deposit ranged in thickness from 6-inches to 3 feet, with increasing sediment thickness away from the floodplain slope;
- Undefined Floodplain Ash Deposit: Encountered at typical depths of 2 to 3 feet below the floodplain floor, the lateral extent of the floodplain ash deposit could not be identified based on visual inspection. Due to the fine grained nature of the ash present in the layer interval 6-inches to 1-foot in thick, the ash likely extends further into the floodplain and could include an additional 500 cy of material. This assumes the ash layer extends 260 feet across the floodplain in a band 50 feet wide and one foot thick. The demarcation line presented on Figure 6 for the potential extent of floodplain ash has been estimated to extend approximately 50 feet beyond where ash was identified in the test trenches.

Based on the configuration of the ash deposit and controlling factors such a location on the floodplain slope or burial of ash with the floodplain deposits, CTI has generated two material estimates to facilitate the remedy decision process. Remedial options considered include: (1) excavation and off-site disposal of the ash as special waste; and, (2) the in-place capping of the ash to eliminate the exposure pathway and establishing institutional controls for future land use.

A third option considered would include a combination of the above two options and would involve removal of the readily accessible ash material on the floodplain side slope and allowing the ash layers within the floodplain sediments to remain in-place. This option was not explored further due to the high cost for excavation, transport, and off-site disposal of the majority of the ash as special waste and retaining the requirement for institutional controls and maintenance for the ash present within the floodplain sediments.

Excavation and Off-site Disposal

Excavation and off-site disposal of the delineated ash deposit would include excavation, transport, and disposal of approximately 2,390 cy of readily accessible material along the floodplain slope. In the floodplain, approximately 540 cy of clean overlying soil would be removed and 190 cy of ash present in layers within the floodplain sediments would be excavated and transported off-site for disposal. The estimate provided includes only the area where ash layers were observed during the test trench investigation and could include removing an additional 1,440 cy of clean overlying soil to gain access to an estimated 500 cy of ash within the floodplain sediments. The actual volumes of overlying soil and ash would depend on the delineated limits of the ash deposit within the floodplain.

The floodplain would then be re-graded using the stockpiled clean soil. Additional soil import of 700 cy likely would be required to backfill the floodplain excavation and attain a stable floodplain slope of 3 to1 or less to prevent future erosion. CTI anticipates 300 cy of soil borrow would be required for final grading.

The challenges associated with this option include the following:

- Delineation of the ash layers within the floodplain sediments appears to become increasingly difficult with increased distance from the ash deposit source area. As a result, this likely would require analytical laboratory testing of the material to identify and characterize the ash layers. If the entire ash deposit is to be removed, additional sampling, either using an excavator or Geoprobe may be necessary to delineate the extent of ash in the floodplain based on analytical laboratory sample results. It is important to note that analytical laboratory results for ash layer grab samples collected from test trenches TP-1 and TP-3 were below the KDHE – RSK residential criteria and ash layer grab samples from TP-4, TP-5, and TP-6 exceeded the KDHE – RSK residential criteria. A grid based composite ash layer sampling strategy has the potential to significantly reduce the required ash removal volume in the floodplain.
- The potential for variability in the depth of the ash layers likely would require a overlying clean floodplain soil removal excavation plan based on further investigation and soil sampling performed in the floodplain area. Analytical laboratory results for floodplain sediment grab samples above the ash layers were below the KDHE – RSK residential criteria. This material would be removed and reused as clean soil backfill.
- Removal of the ash deposit along the floodplain slope in the vicinity of the western power pole likely would require modification to the power pole guy wires due to the potential for undermining the power pole support during excavation.
- Confirmation sampling to document removal of the ash deposit from the floodplain slope and the floodplain ash layers within the floodplain sediments would be required to document closure under the KDHE - RSK residential criteria. Based on analytical laboratory samples collected during the CFI test trench investigation, soil grab samples below the ash deposit were below the KDHE – RSK residential criteria.

The benefit of excavation and off-site disposal of the CFI ash deposit is the material would be removed from the site and long-term institutional controls or maintenance in the area would not be required. The relative cost associated with excavation and off-site disposal would be highest of the two remedial options presented.

In-Place Ash Capping and Institutional Controls

In-place ash capping would include reshaping the floodplain slope ash disposal area to move the ash and soil from the crest and upper reaches of the slope to mid slope and the base of the slope to minimize the potential for erosion at the top of the slope. This would decrease the slope grade from the current 3 to 1 to a more stable slope of 4 to 1. In the vicinity of the power pole guy wires, additional fill would be placed in this area to attain the 4 to 1 slope and would eliminate concerns regarding excavation in the area of the power pole support guy wires. Due to the unknown extent of ash layers within the floodplain sediments, CTI recommends expanding the area designated for land-use restrictions to encompass 50 to 100 feet of the floodplain to avoid cost associated with further delineation of the ash layers.

Construction of a 2-foot soil cover over the graded area of approximately 260 feet x 100 feet would require approximately 1,920 cy of soil from an on-base borrow area. The cover at the base of the slope would extend onto the floodplain to ensure sufficient soil cover is in place areas where the ash layers are present at a shallow depth within the floodplain sediments. Further evaluation of the construction limitations in the vicinity of the power pole guy wires would need to be confirmed with the power company prior to determining final soil cap volumes.

The in-place cover and institutional controls for the CFI ash deposit do not present significant construction challenges. Close proximity of an on-base soil borrow source would reduce cost by reducing truck turn-around time. Cover soils could be dumped at the top of the floodplain slope and graded to the required cap thickness requirements using field grade stakes. The long-term disadvantages of institutional controls would be the requirement to perform site inspections and the potential for maintenance of the cover, and the continuation of this area within the Army IRP program.

The benefit of in-place cover and institutional controls of the CFI ash deposit is the significantly lower cost than that of removal and off-site disposal.

Table 1
Laboratory Analytical Sample Summary - Test Trenching
Camp Funston Incinerator Investigation
Fort Riley, Kansas

Test Trench I.D. No.	Sample I.D.	Analytical Methods	Comments
TP-1	CFI TP-1 Composite	RCRA 8 Metals/TCLP	Three sub-sample composite
	CFI TP-1-30'-36" SBA	RCRA 8 Metals	In-place soil below ash deposit
	CFI TP-1-55'-24" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
	CFI TP-1-65'-42" ASH	RCRA 8 Metals/TCLP	Ash deposit with floodplain soil
TP-2	CFI TP-2 Composite	RCRA 8 Metals/TCLP	Five sub-sample composite
	CFI TP-2-20'-36" SBA	RCRA 8 Metals	In-place soil below ash deposit
	CFI TP-2-55'-24" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
TP-3	CFI TP-3 Composite	RCRA 8 Metals/TCLP	Three sub-sample composite
	CFI TP-3-25'-36" SBA	RCRA 8 Metals	In-place soil below ash deposit
	CFI TP-3-60'-36" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
	CFI TP-3-60'-42" ASH	RCRA 8 Metals/TCLP	Ash deposit with floodplain soil
TP-4	CFI TP-4 Composite	RCRA 8 Metals/TCLP	Three sub-sample composite
	CFI TP-4-65'-60" ASH	RCRA 8 Metals/TCLP	Ash deposit with floodplain soil
	CFI TP-4-65'-30" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
TP-5	CFI TP-5 Composite	RCRA 8 Metals/TCLP	Four sub-sample composite
	CFI TP-5-70'-54" ASH	RCRA 8 Metals/TCLP	Ash deposit with floodplain soil
	CFI TP-5-80'-24" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
TP-6	CFI TP-6 Composite	RCRA 8 Metals/TCLP	Three sub-sample composite
	CFI TP-6-15'-72" SWA	RCRA 8 Metals	Disturbed soil below ash deposit with ash seam
	CFI TP-6-60'-24" SAA	RCRA 8 Metals	In-place floodplain soil above ash deposit
	CFI TP-6-60'-48" ASH	RCRA 8 Metals/TCLP	Ash deposit with floodplain soil

CFI - Camp Funston Incinerator
TCLP - Toxicity Characterictic Leaching Procedure
SAA - Soil Above Ash
SBA - Soil Below Ash
SWA - Soil With Ash
ASH - Ash Sample

Table 2
Summary of Analytical Laboratory Results - Test Trenching
Camp Funston WWI Incinerator
Fort Riley, Kansas

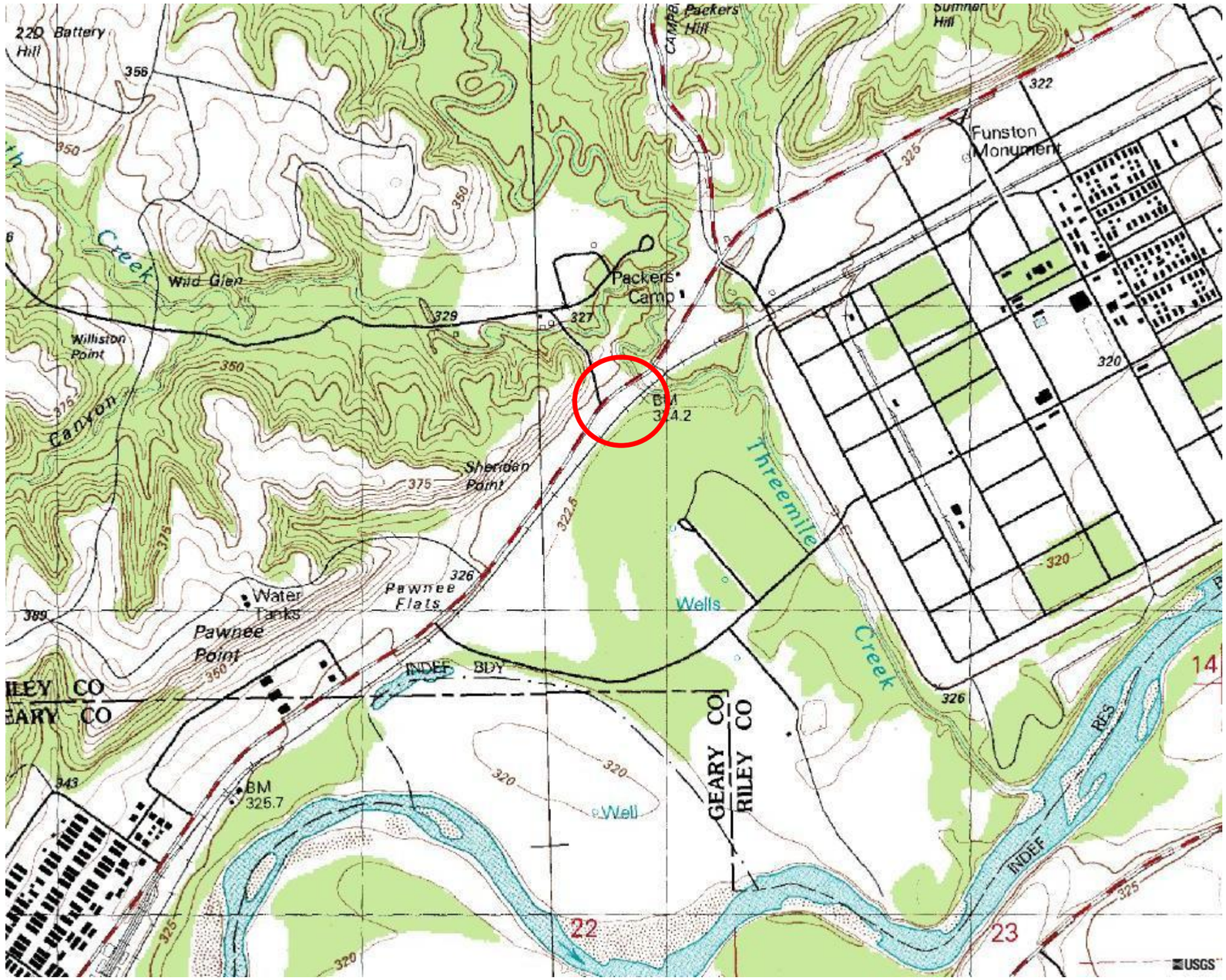
Compound	Arsenic		Barium		Cadmium		Chromium		Lead		Mercury		Selenium		Silver	
Analytical Laboratory Method	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)
Regulatory Limits	11	5.0	5500	100.0	39	1.0	390	5.0	400	5.0	2	0.2	390	1.0	390	5.0
CFI TP-1 Composite	**16.2**	ND	784	1.6	1.3	ND	16.2	ND	76.8	0.10J	0.11	0.0017J	0.66J	ND	0.11J	ND
CFI TP-1-30'-36" SBA	5		156		ND		13.9		44		0.023J		ND		ND	
CFI TP-1-55'-24" SAA	5.2		192		ND		17.5		13.7		0.026J		ND		ND	
CFI TP-1-65'-42" ASH	6.4	ND	199	0.96J	0.36J	ND	16.8	0.011J	30.4	ND	0.064	ND	ND	ND	ND	ND
CFI TP-2 Composite	**22.8**	0.094J	354	0.62J	3.2	0,017J	11.4	ND	126	0.034J	0.074	0.0020J	ND	ND	ND	ND
CFI TP-2-20'-36" SBA	4.5		139		0.25J		11.8		14.9		0.015J		ND		ND	
CFI TP-2-55'-24" SAA	4.2		174		0.15J		16.3		13		0.067		ND		ND	
CFI TP-3 Composite	**20.7**	ND	1380	1.1	1.7	.014J	11.5	ND	120	0.069J	0.057	0.0012J	0.86J	ND	0.24J	ND
CFI TP-3-25'-36" SBA	3.3		113		0.11J		11.5		8.5		ND		ND		ND	
CFI TP-3-60'-36" SAA	5.2		184		0.092J		17.7		14.2		0.025J		ND		ND	
CFI TP-3-60'-42" ASH	10.7	ND	1030	1	1.8	0.019J	12.6	0.014J	57	0.068J	0.072	ND	ND	ND	ND	ND
CFI TP-4 Composite	**22.3**	ND	439	0.45J	3.1	0.023J	10.8	ND	143	0.058J	0.65	ND	0.73J	ND	0.32J	ND
CFI TP-4-65'-60" ASH	**86.9**	ND	370	0.97J	2.2	0.017J	13	0.015J	366	0.037J	0.11	ND	0.84J	ND	0.94J	0.011J
CFI TP-4-65'-30" SAA	5		191		0.13J		17.4		14.3		0.016J		ND		ND	
CFI TP-5 Composite	**27.1**	ND	763	0.20J	7.3	0.031J	12.6	ND	199	0.042J	0.2	ND	ND	ND	0.42J	ND
CFI TP-5-70'-54" ASH	**21.8**	ND	368	0.38J	15.6	0.013J	8.4	ND	91.6	0.024J	0.074	ND	1.0J	ND	0.19J	ND
CFI TP-5-80'-24" SAA	3.7		129		ND		13.2		10.3		0.015J		ND		ND	
CFI TP-6 Composite	**34.4**	0.060J	542	0.65J	3.7	0.028J	14.5	0.012J	334	0.094J	ND	ND	0.59J	ND	0.41J	ND
CFI TP-6-15'-72" SNA	3.5		126		ND		13.4		8.9		ND		ND		ND	
CFI TP-6-60'-24" SAA	5.4		198		ND		20.3		14.4		0.014J		ND		ND	
CFI TP-6-60'-48" ASH	**26.8**	ND	244	0.98J	1.9	0.010J	16.3	ND	182	0.034J	0.13	ND	ND	ND	0.53J	ND

Anaytical Laboratory Methods: 8 RCRA Metals/TCLP by EPA SW846-6010 and 7470/7471 (Mercury).
Regulatory Limits: RCRA 8 Total Metals - KDHE Tier 2 Risk-Based Residential Criteria, TCLP - Regulatory Limits.
SAA - Soil Above Ash
SBA - Soil Below Ash
SNA - Soil No Ash
ASH - Ash Sample

Table 3
Summary of Analytical Laboratory Results - Upland Confirmation Samples
Camp Funston WWI Incinerator
Fort Riley, Kansas

Compound	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Analytical Laboratory Method	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)	Total (mg/kg)
Regulatory Limits	11	5500	39	390	400	2.0	390	390
CFI - Q1	4.5	109	0.27J	7.3	14.2	0.26	0.30J	0.15J
CFI - Q2	4.2	106	0.30J	7.5	12.6	0.70	0.22J	0.14J
CFI - Q3	3.7	97.5	0.44J	7.9	14.6	0.67	0.31J	0.17J
CFI - Q4	2.9	90.5	0.17J	7.5	6.9	0.01J	0.28J	0.12J
CFI - Q5	5.0	99.7	0.40J	7.7	16.8	0.25J	ND	0.16J
CFI - PAD - C	3.2	78.5	0.13J	8.0	7.0	ND	ND	0.13J
CFI - SP -5	3.9	108	0.40J	7.9	11.5	**3.4**	0.25J	0.14J
CFI - SP -8	3.7	88.9	0.22J	8.6	9.7	0.39	ND	0.073J
CFI - SP -13	**13.8**	109	1.9	8.3	67.3	0.12	0.66J	0.23J

Anaytical Laboratory Methods: 8 RCRA Metals/TCLP by EPA SW846-6010 and 7470/7471 (Mercury).
Regulatory Limits: RCRA 8 Total Metals - KDHE Tier 2 Risk-Based Residential Criteria, TCLP - Regulatory Limits.
Q1 through Q5 - Upland Soil Confirmation Quadrant
CFI - PAD - C: Confirmation Soil Sample Below Incinerator Pad
CFI - SP - 5 through CFI - SP - 13: Railroad Spur Soil Pile Sample Result



LEGEND

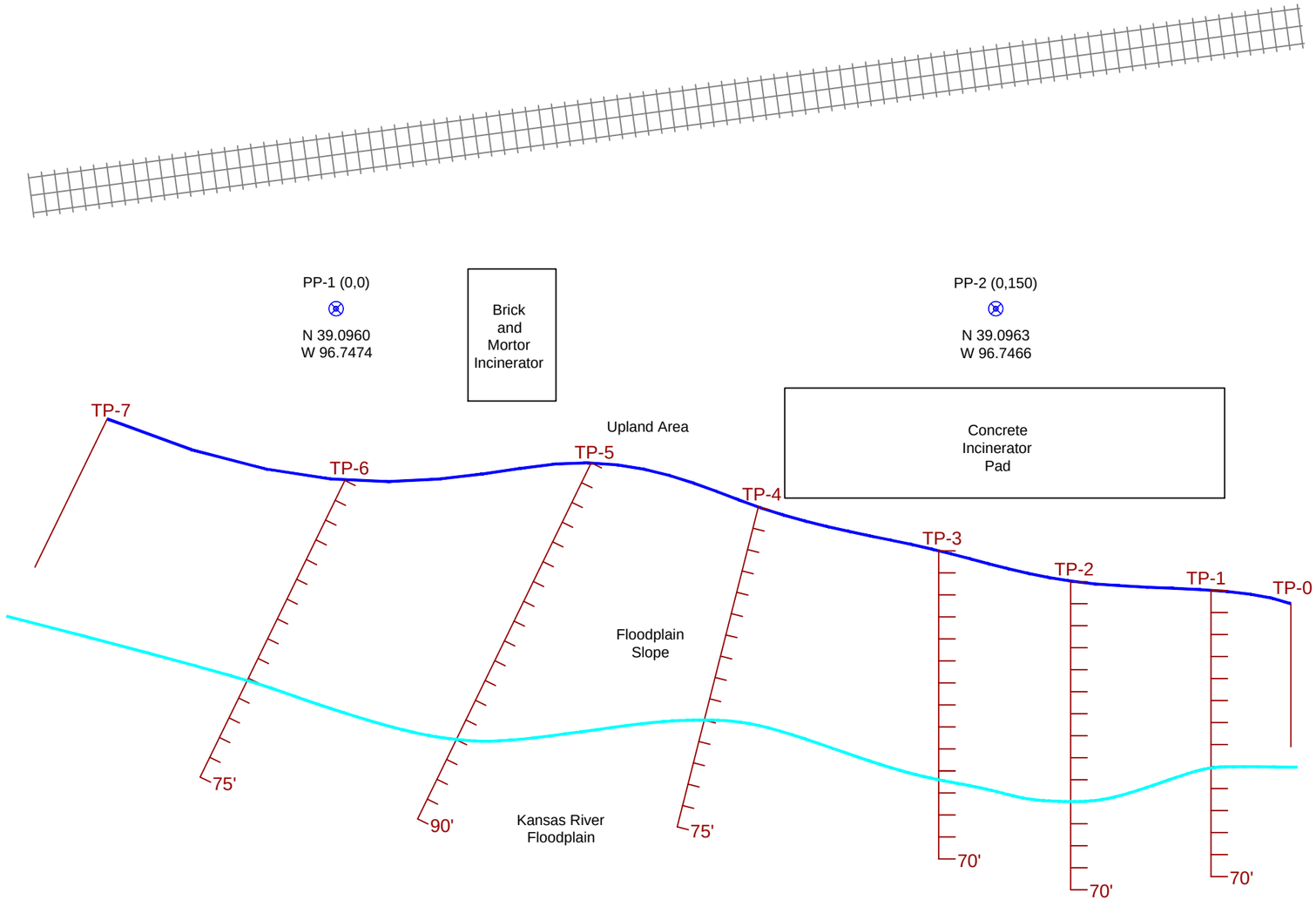
Camp Funston WWI Incinerator

US Army Corps of Engineers

Camp Funston WWI Incinerator
Fort Riley, Kansas

CTI and Associates, Inc.

FIGURE 1
Camp Funston WWI Incinerator Location Map



LEGEND

- ⊗ - Power Pole
- - Railroad Siding
- - Approximate Top of Slope
- - Approximate Base of Slope at Floodplain
- TP-1 - TP-1 Test Trenches (5 ft increments)

30 0 30 60

SCALE IN FEET

Field Coordinate System North

US Army Corps of Engineers
Kansas City District

Camp Funston WWI Incinerator
Fort Riley, Kansas

CTI and Associates, Inc.

Figure 2

CFI Work Area Layout

US Army Corps of Engineers

Camp Funston WWI Incinerator
Fort Riley, Kansas

CTI and Associates, Inc.

FIGURE 3
Incinerator Ash Photographs – Floodplain Slope

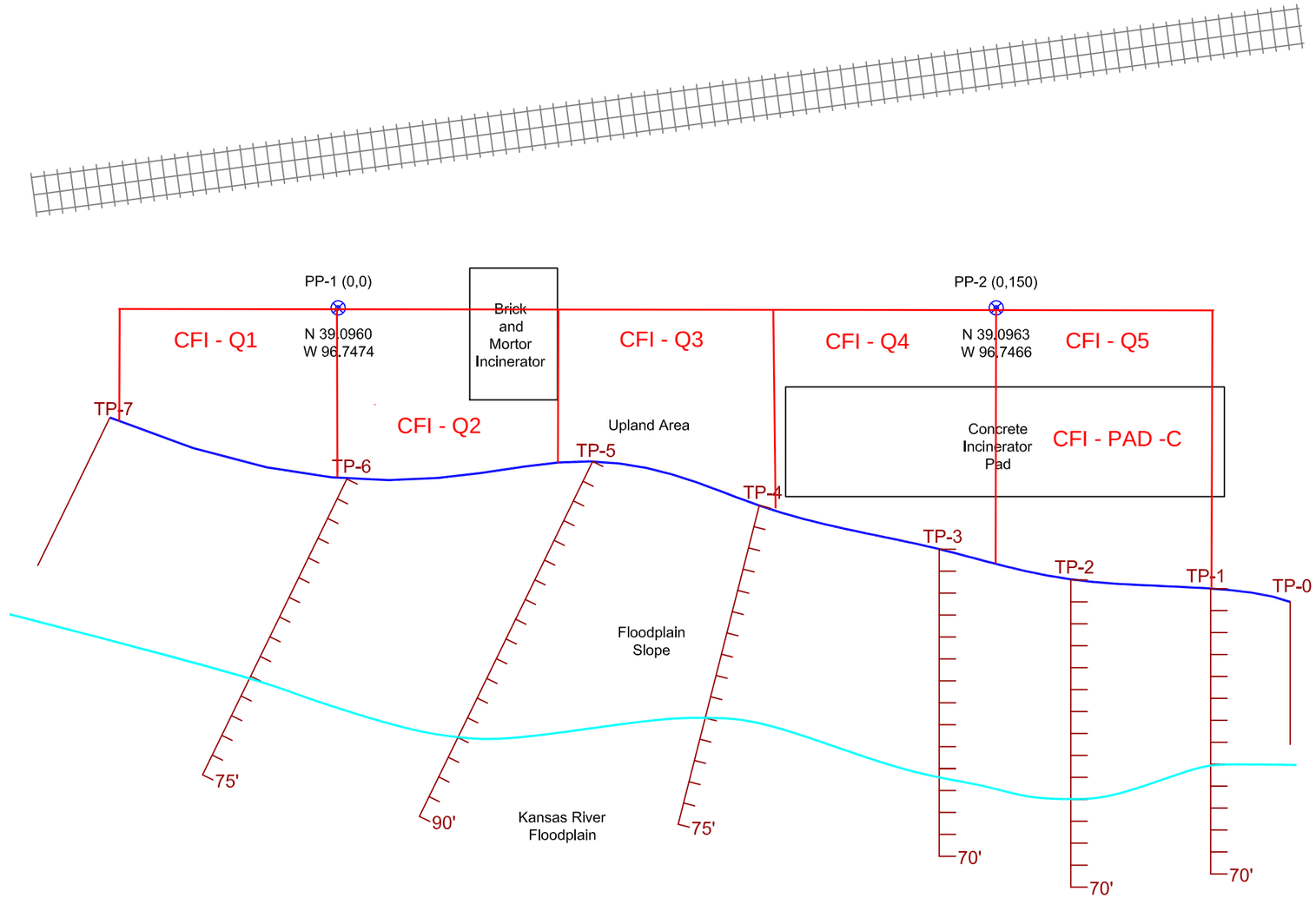
US Army Corps of Engineers

Camp Funston WWI Incinerator
Fort Riley, Kansas

CTI and Associates, Inc.

FIGURE 4

Ash Layer Photographs – Floodplain Deposits



LEGEND

- ⊗ - Power Pole
- - Railroad Siding
- - Approximate Top of Slope
- - Approximate Base of Slope at Floodplain
- TP-1 - TP-1 Test Trenches (5 ft increments)

Field Coordinate System North

30 0 30 60
SCALE IN FEET

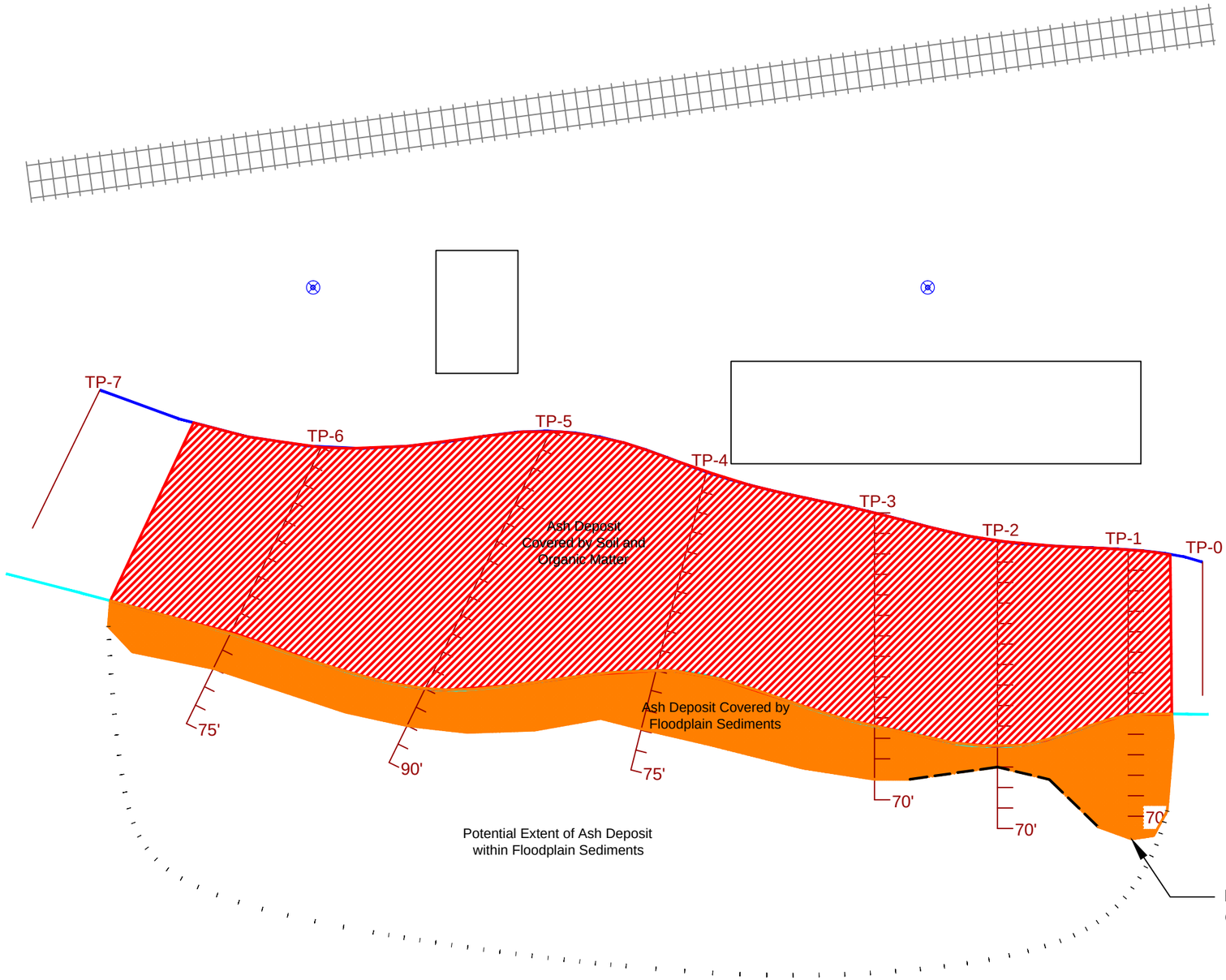
US Army Corps of Engineers
Kansas City District

Camp Funston WWI Incinerator
Fort Riley, Kansas

CTI and Associates, Inc.

Figure 5

Upland Soil Confirmation Grid



LEGEND

- Power Pole
- Railroad Siding
- Approximate Top of Slope
- Approximate Base of Slope at Floodplain
- TP-1 Test Trenches (5 ft increments)

Field Coordinate System North

30 0 30 60

SCALE IN FEET

US Army Corps of Engineers
Kansas City District

Camp Funston WWI Incinerator
Fort Riley, Kansas

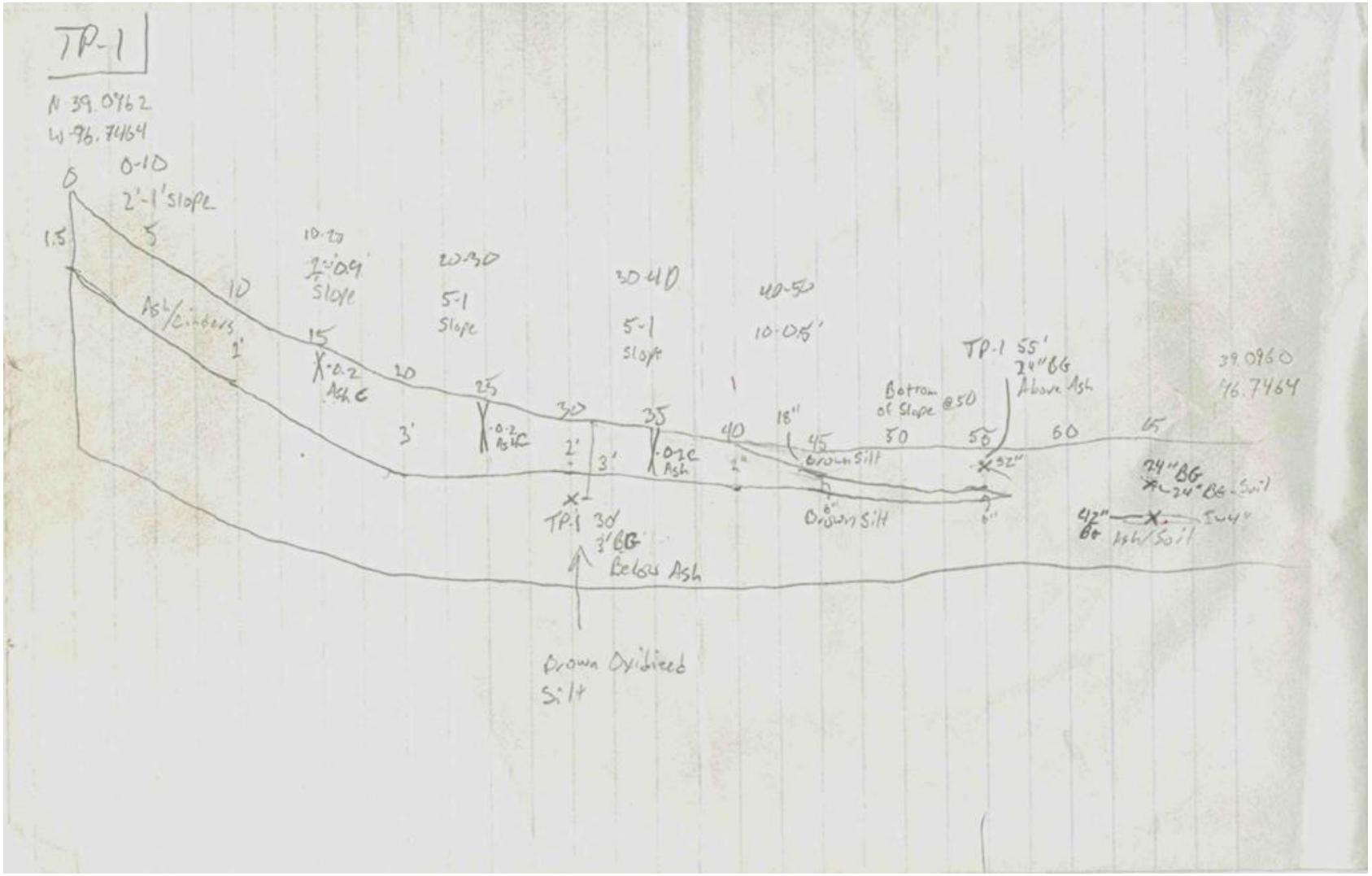
CTI and Associates, Inc.

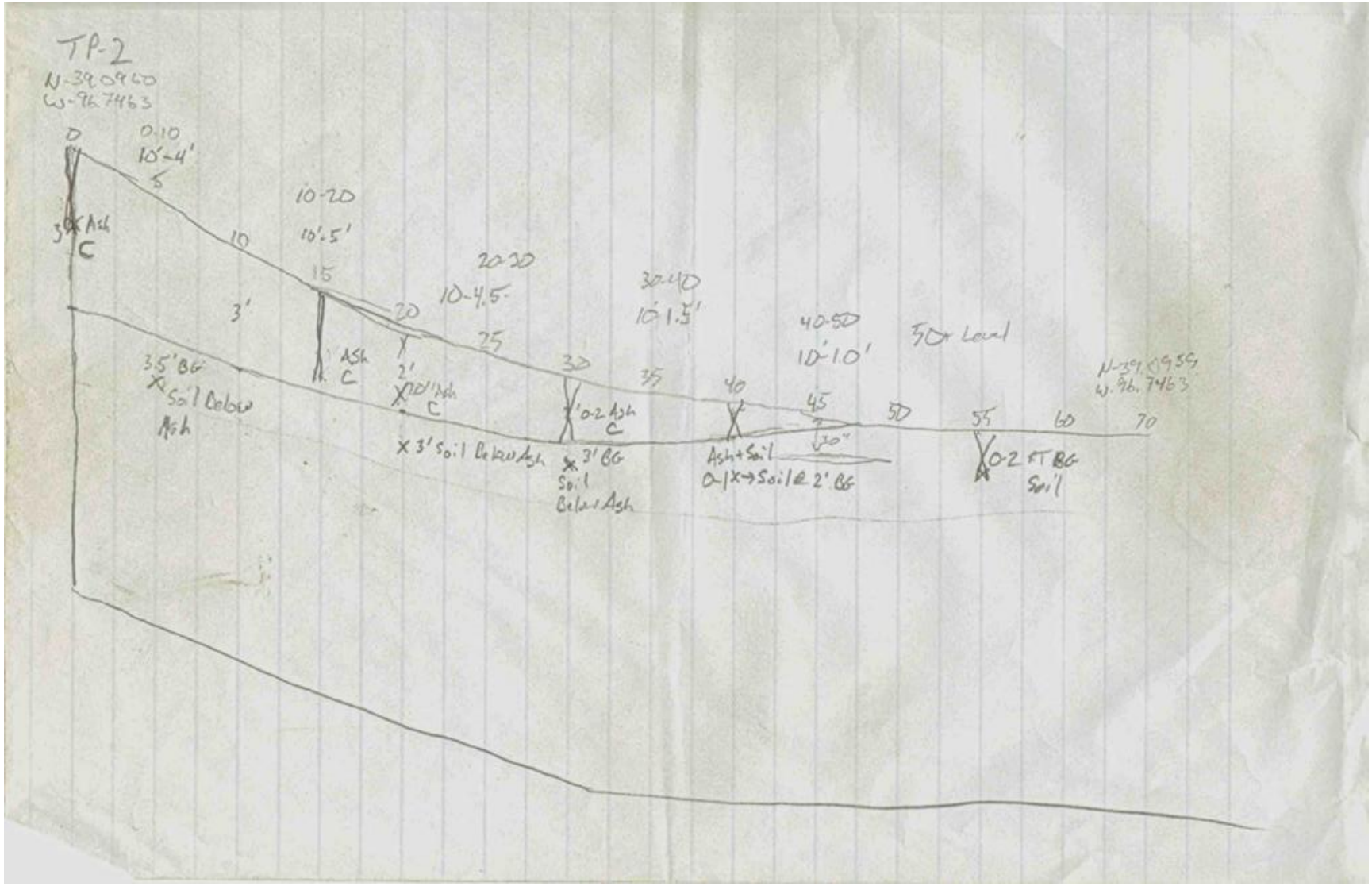
Figure 6

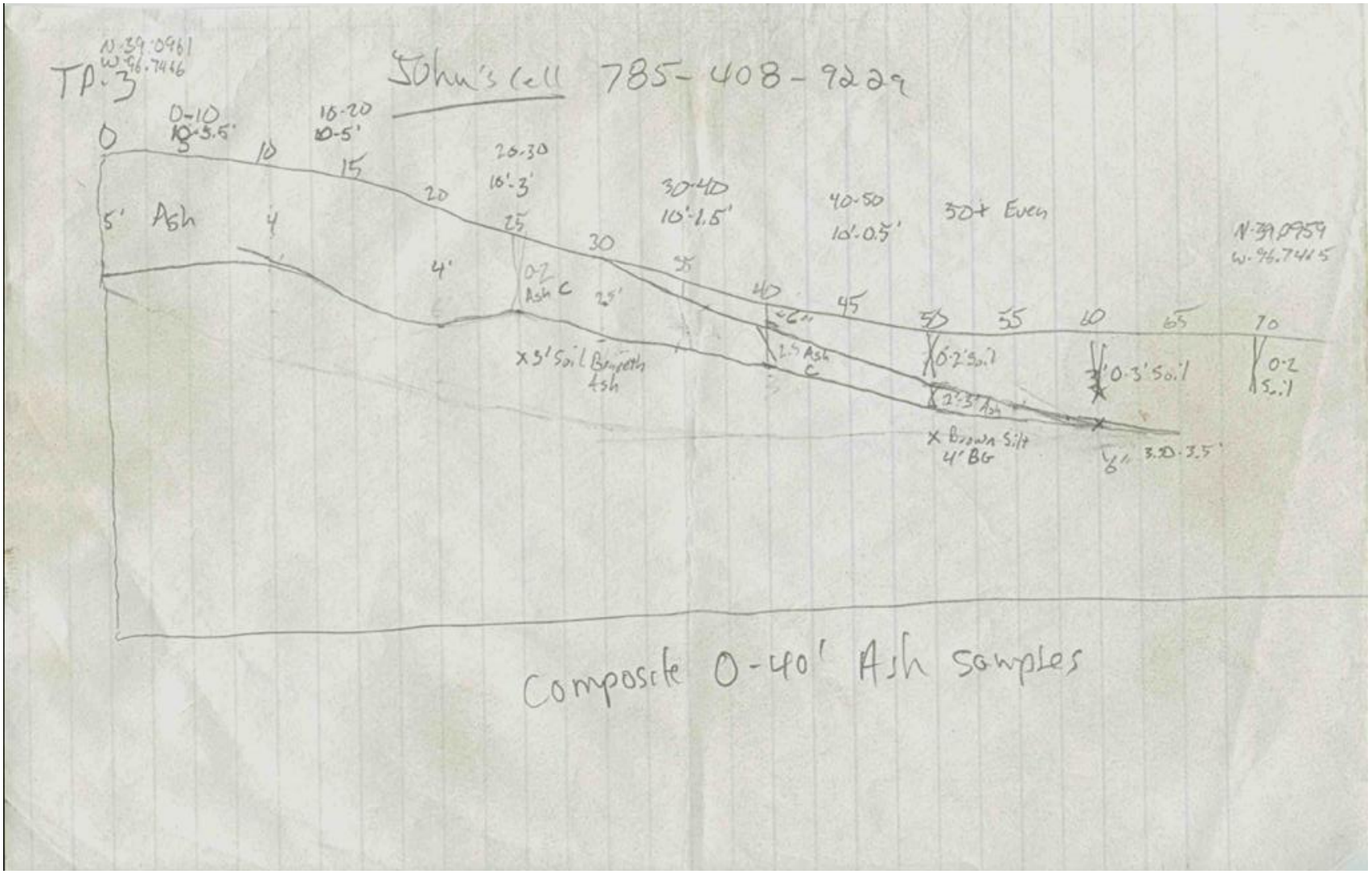
Extent of Ash Deposit

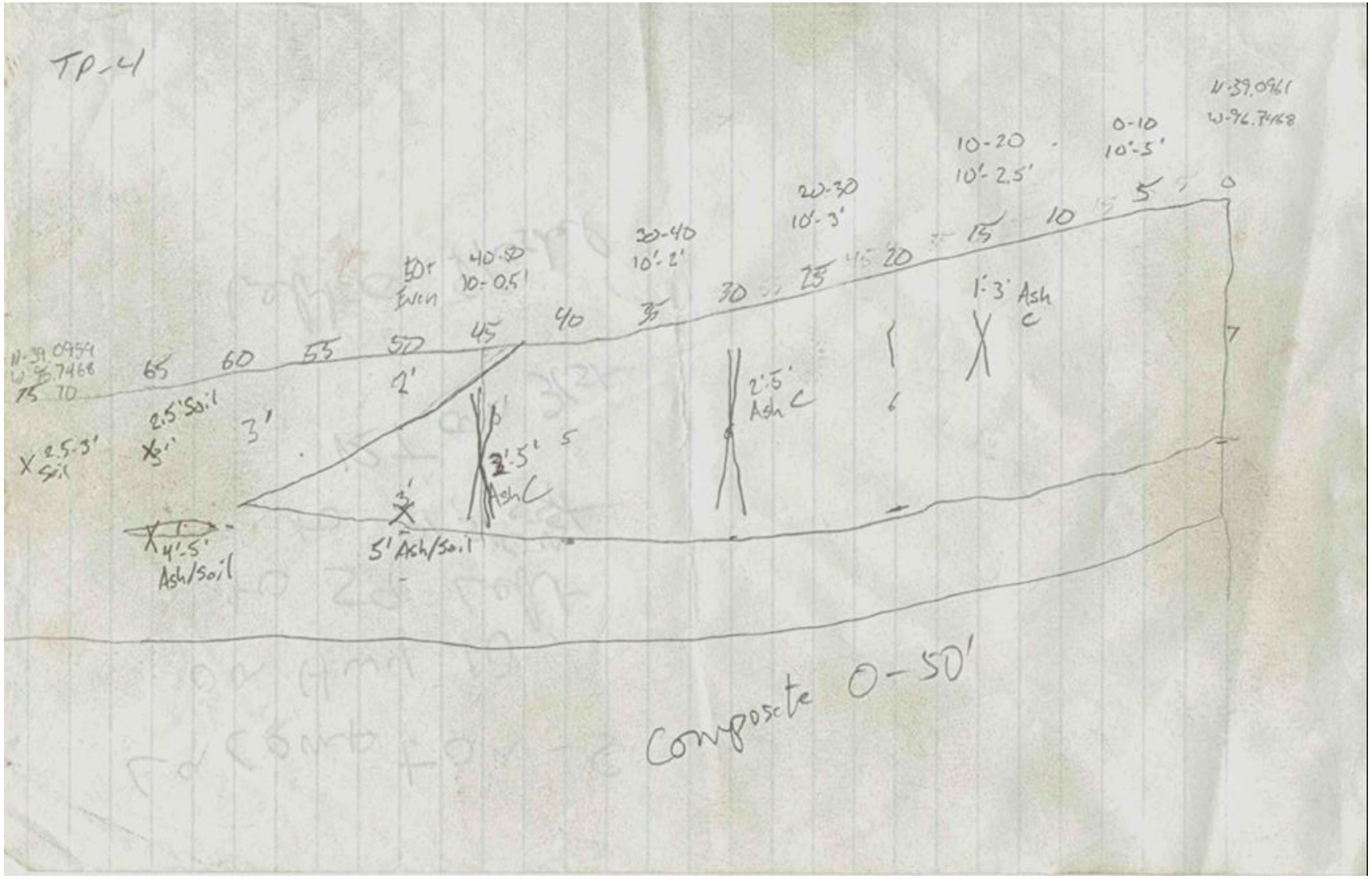
Attachment A

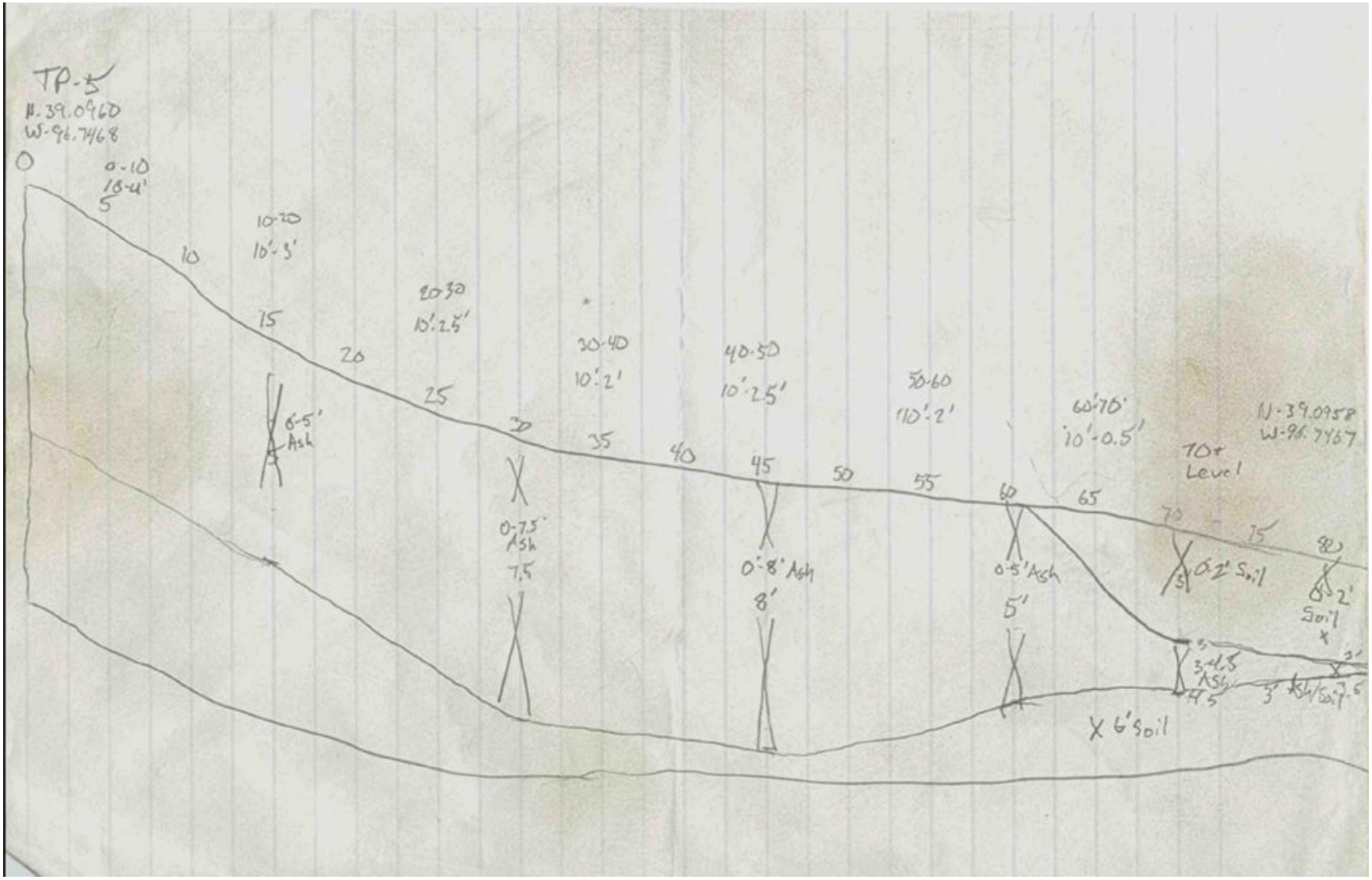
Test Trench Field Logs

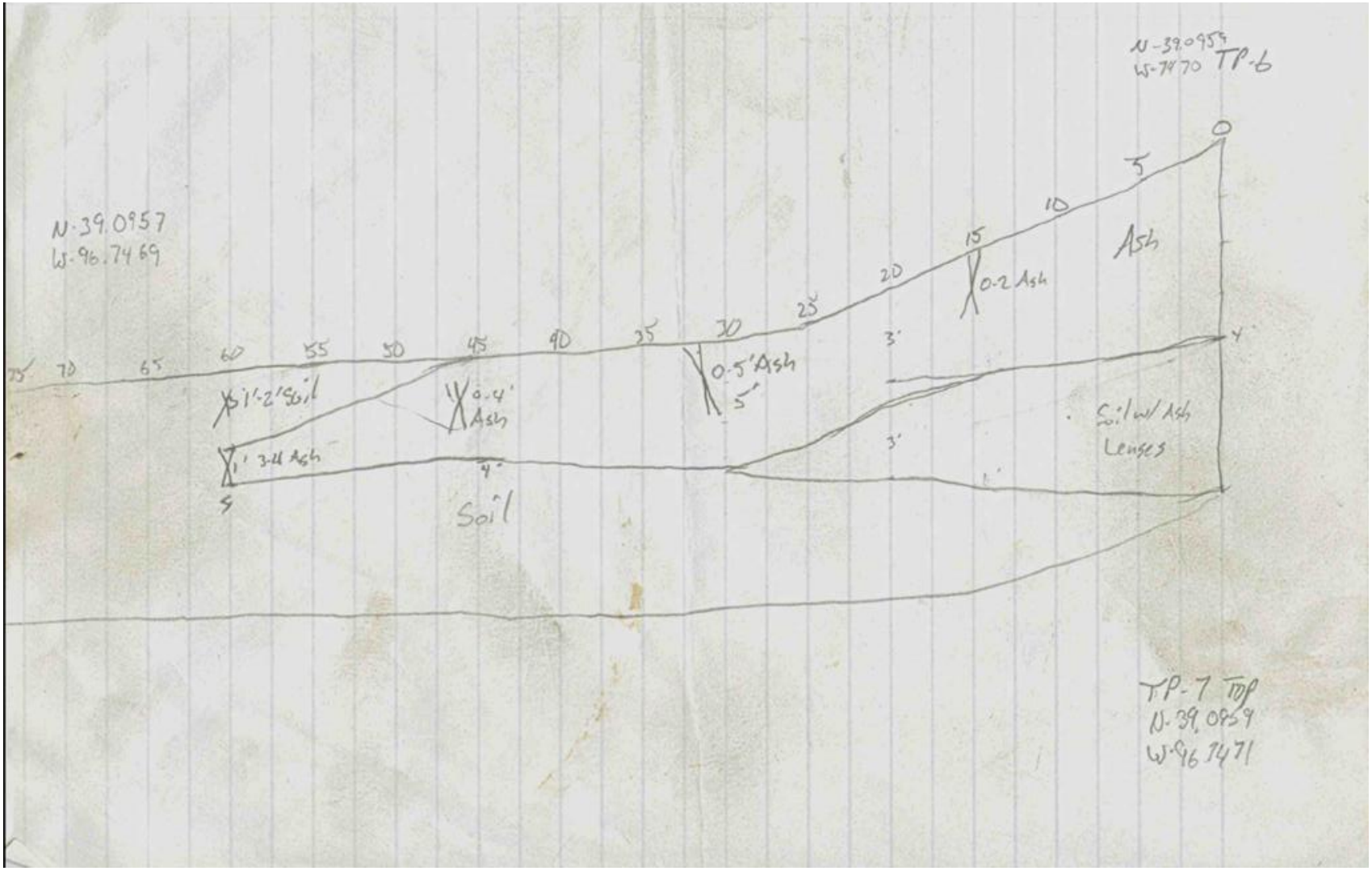

TP-1
N 39.0962
W 96.7464
0-10
2'-1' slope
10-20
2'-0.9' slope
20-30
5-1 slope
30-40
5-1 slope
40-50
10-0.5'
Ash/Cinders
Bottom of Slope @50
TP-1 55'
24" BG
Above Ash
39.0960
96.7464
Brown Silt
Brown Silt
TP-1 30'
3' BG
Below Ash
Brown Oxidized Silt
24" BG
24" BG - Soil
42" BG
Ash/Soil


TP-2
N-39.0960
W-96.7463
0
0-10
10'-4'
5
10-20
10'-5'
10
15
20-30
10-4.5
20
25
30-40
10'-1.5'
30
35
40-50
10'-1.0'
40
45
50
55
60
70
50+ Level
N-39.0959
W-96.7463
3' Ash
C
3'
Ash
C
2'
2.0' Ash
C
3.5' BG
Soil Below
Ash
3' Soil Below Ash
0-2 Ash
C
3' BG
Soil
Below Ash
Ash+Soil
0-1 X→Soil @ 2' BG
30"
0-2 FT BG
Soil


TP-3
N-39.0961
W-96.7466
John's Cell 785-408-9229
0-10
10-5.5'
10-20
10-5'
20-30
10'-3'
30-40
10'-1.5'
40-50
10'-0.5'
50+ Even
N-39.0959
W-96.7465
5' Ash
4'
0-2
Ash C
2.5'
x 3' Soil Beneath Ash
2.5 Ash C
0-2' Soil
2'-3' Ash
x Brown Silt
4' BG
0-3' Soil
0-2
Soil
3.0-3.5'
Composite 0-40' Ash samples


TP-4
N-39.0961
W-96.7468
0-10
10'-5'
10-20
10'-2.5'
20-30
10'-3'
30-40
10'-2'
40-50
10-0.5'
50+
Even
N-39.0954
W-96.7468
75 70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2'
3'
2.5' Soil
2.5-3' Soil
4'-5' Ash/Soil
5' Ash/Soil
2'-5' Ash C
2'-5' Ash C
1'-3' Ash C
Composite 0-50'


TP-5
N-39.0960
W-96.7468
0
0-10
10-4'
5
10
10-20
10'-3'
15
20
20-30
10'-2.5'
25
30
30-40
10'-2'
35
40
40-50
10'-2.5'
45
50
50-60
10'-2'
55
60
60-70
10'-0.5'
65
70+
Level
70
75
80
N-39.0958
W-96.7467
0-5'
Ash
0-7.5'
Ash
7.5
0-8' Ash
8'
0-5' Ash
5'
0-2' Soil
0-2'
Soil
3-4.5
Ash
4.5
3' Ash/Soil
X 6' Soil


N-39.0957
W-96.7469
N-39.0953
W-96.770 TP-6
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Ash
0-2 Ash
0-5' Ash
5'
0-4'
Ash
1'-2' Soil
1' 3-4 Ash
5
4'
Soil
3'
3'
4
Soil w/ Ash
Lenses
TP-7 Top
N-39.0959
W-96.7471

Attachment B

Analytical Laboratory Results

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

October 06, 2010

Robert Stenson
CTI and Associates, Inc.
1202 W. Washington Ave.
Cleveland, WI 53015

RE: Project: CFI FORT RILEY
Pace Project No.: 6086755

Dear Robert Stenson:
Enclosed are the analytical results for sample(s) received by the laboratory on October 04, 2010. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jamie Slade

jamie.slade@pacelabs.com
Project Manager

Enclosures

cc: David Plumb, CTI and Associates, Inc.

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CERTIFICATIONS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Kansas Certification IDs
9608 Loiret Boulevard, Lenexa, KS 66219
A2LA Certification #: 2456.01
Arkansas Certification #: 05-008-0
Illinois Certification #: 001191
Iowa Certification #: 118
Kansas/NELAP Certification #: E-10116
Louisiana Certification #: 03055
Nevada Certification #: KS000212008A
Oklahoma Certification #: 9205/9935
Texas Certification #: T104704407-08-TX
Utah Certification #: 9135995665

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SAMPLE SUMMARY

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6086755001	**CFI TP-1 COMPOSITE**	Solid	10/01/10 14:15	10/04/10 09:15
6086755002	**CFI TP-1-30-36 SBA**	Solid	10/01/10 14:20	10/04/10 09:15
6086755003	**CFI TP-1-55-24 SAA**	Solid	10/01/10 14:25	10/04/10 09:15
6086755004	**CFI TP-1-65-42 ASH**	Solid	10/01/10 14:30	10/04/10 09:15
6086755005	**CFI TP-2 COMPOSITE**	Solid	10/01/10 14:35	10/04/10 09:15
6086755006	**CFI TP-2-20-36 SBA**	Solid	10/01/10 14:40	10/04/10 09:15
6086755007	**CFI TP-2-55-24 SAA**	Solid	10/01/10 14:45	10/04/10 09:15
6086755008	**CFI TP-3 COMPOSITE**	Solid	10/01/10 14:50	10/04/10 09:15
6086755009	**CFI TP-3-25-36 SBA**	Solid	10/01/10 14:55	10/04/10 09:15
6086755010	**CFI TP-3-60-36 SAA**	Solid	10/01/10 15:00	10/04/10 09:15
6086755011	**CFI TP-3-60-42 ASH**	Solid	10/01/10 15:05	10/04/10 09:15
6086755012	**CFI TP-4 COMPOSITE**	Solid	10/01/10 15:10	10/04/10 09:15
6086755013	**CFI TP-4-65-60 ASH**	Solid	10/01/10 15:15	10/04/10 09:15
6086755014	**CFI TP-4-65-30 SAA**	Solid	10/01/10 15:20	10/04/10 09:15
6086755015	**CFI TP-5 COMPOSITE**	Solid	10/01/10 15:25	10/04/10 09:15
6086755016	**CFI TP-5 70-54 ASH**	Solid	10/01/10 15:30	10/04/10 09:15
6086755017	**CFI TP-5 80-24 SAA**	Solid	10/01/10 15:35	10/04/10 09:15
6086755018	**CFI TP-6 COMPOSITE**	Solid	10/01/10 15:40	10/04/10 09:15
6086755019	**CFI TP-6 15-72 SNA**	Solid	10/01/10 15:45	10/04/10 09:15
6086755020	**CFI TP-6 60-24 SAA**	Solid	10/01/10 15:50	10/04/10 09:15
6086755021	**CFI TP-6 60-48 ASH**	Solid	10/01/10 15:55	10/04/10 09:15

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SAMPLE ANALYTE COUNT

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6086755001	**CFI TP-1 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755002	**CFI TP-1-30-36 SBA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755003	**CFI TP-1-55-24 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755004	**CFI TP-1-65-42 ASH**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755005	**CFI TP-2 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755006	**CFI TP-2-20-36 SBA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755007	**CFI TP-2-55-24 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755008	**CFI TP-3 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755009	**CFI TP-3-25-36 SBA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755010	**CFI TP-3-60-36 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1

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SAMPLE ANALYTE COUNT

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	Method	Analysts	Analytes Reported
		ASTM D2974-87	JHA	1
6086755011	**CFI TP-3-60-42 ASH**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755012	**CFI TP-4 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755013	**CFI TP-4-65-60 ASH**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755014	**CFI TP-4-65-30 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755015	**CFI TP-5 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755016	**CFI TP-5 70-54 ASH**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755017	**CFI TP-5 80-24 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755018	**CFI TP-6 COMPOSITE**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1

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SAMPLE ANALYTE COUNT

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6086755019	**CFI TP-6 15-72 SNA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755020	**CFI TP-6 60-24 SAA**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	JHA	1
6086755021	**CFI TP-6 60-48 ASH**	EPA 6010	SMW	7
		EPA 6010	SMW	7
		EPA 7470	JDH	1
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1

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PROJECT NARRATIVE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Method: **EPA 6010**
Description: 6010 MET ICP
Client: CTI and Associates, Inc.
Date: October 06, 2010

General Information:
21 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3050 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: MPRP/12410

A matrix spike and matrix spike duplicate (MS/MSD) were performed on the following sample(s): 6086755021

M0: Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

- MS (Lab ID: 711842)
  - Barium
  - Lead
  - Selenium

QC Batch: MPRP/12409

A matrix spike and matrix spike duplicate (MS/MSD) were performed on the following sample(s): 6086755001

M0: Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

- MS (Lab ID: 711836)
  - Barium
  - Chromium
  - Selenium

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Method: **EPA 6010**
Description: 6010 MET ICP
Client: CTI and Associates, Inc.
Date: October 06, 2010

Analyte Comments:

QC Batch: MPRP/12409

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- CFI TP-1-30-36 SBA (Lab ID: 6086755002)
  - Cadmium
- CFI TP-1-55-24 SAA (Lab ID: 6086755003)
  - Cadmium
- CFI TP-1-65-42 ASH (Lab ID: 6086755004)
  - Selenium
- CFI TP-2 COMPOSITE (Lab ID: 6086755005)
  - Selenium
- CFI TP-2-20-36 SBA (Lab ID: 6086755006)
  - Selenium
- CFI TP-2-55-24 SAA (Lab ID: 6086755007)
  - Selenium
- CFI TP-3-25-36 SBA (Lab ID: 6086755009)
  - Selenium
- CFI TP-3-60-36 SAA (Lab ID: 6086755010)
  - Selenium
- CFI TP-3-60-42 ASH (Lab ID: 6086755011)
  - Selenium
- CFI TP-4-65-30 SAA (Lab ID: 6086755014)
  - Selenium
- CFI TP-5 80-24 SAA (Lab ID: 6086755017)
  - Cadmium
- CFI TP-5 COMPOSITE (Lab ID: 6086755015)
  - Selenium
- CFI TP-6 15-72 SNA (Lab ID: 6086755019)
  - Cadmium
- CFI TP-6 60-24 SAA (Lab ID: 6086755020)
  - Cadmium

QC Batch: MPRP/12410

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- CFI TP-6 60-48 ASH (Lab ID: 6086755021)
  - Selenium

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PROJECT NARRATIVE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Method: **EPA 6010**
Description: 6010 MET ICP, TCLP
Client: CTI and Associates, Inc.
Date: October 06, 2010

General Information:
11 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Method: **EPA 7470**
Description: 7470 Mercury, TCLP
Client: CTI and Associates, Inc.
Date: October 06, 2010

General Information:
11 samples were analyzed for EPA 7470. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 7470 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Method: **EPA 7471**
Description: 7471 Mercury
Client: CTI and Associates, Inc.
Date: October 06, 2010

General Information:
21 samples were analyzed for EPA 7471. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 7471 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-1 COMPOSITE **Lab ID: 6086755001** Collected: 10/01/10 14:15 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**16.2**	mg/kg	2.4	0.45	2	10/04/10 15:25	10/05/10 16:30	7440-38-2	
Barium	**784**	mg/kg	2.4	0.071	2	10/04/10 15:25	10/05/10 16:30	7440-39-3	
Cadmium	**1.3**	mg/kg	1.2	0.064	2	10/04/10 15:25	10/05/10 16:30	7440-43-9	
Chromium	**16.2**	mg/kg	1.2	0.099	2	10/04/10 15:25	10/05/10 16:30	7440-47-3	
Lead	**76.8**	mg/kg	1.2	0.28	2	10/04/10 15:25	10/05/10 16:30	7439-92-1	
Selenium	**0.66J**	mg/kg	3.5	0.52	2	10/04/10 15:25	10/05/10 16:30	7782-49-2	
Silver	**0.11J**	mg/kg	1.7	0.078	2	10/04/10 15:25	10/05/10 16:30	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 18:54	7440-38-2	
Barium	**1.6**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 18:54	7440-39-3	
Cadmium	ND	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 18:54	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 18:54	7440-47-3	
Lead	**0.10J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 18:54	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 18:54	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 18:54	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	**0.17J**	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 16:49	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.11**	mg/kg	0.054	0.0096	1	10/05/10 11:10	10/05/10 15:50	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.0**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-1-30-36 SBA **Lab ID: 6086755002** Collected: 10/01/10 14:20 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.0**	mg/kg	2.2	0.42	2	10/04/10 15:25	10/05/10 17:09	7440-38-2	
Barium	**156**	mg/kg	2.2	0.066	2	10/04/10 15:25	10/05/10 17:09	7440-39-3	
Cadmium	ND	mg/kg	1.1	0.059	2	10/04/10 15:25	10/05/10 17:09	7440-43-9	D3
Chromium	**13.9**	mg/kg	1.1	0.092	2	10/04/10 15:25	10/05/10 17:09	7440-47-3	
Lead	**44.0**	mg/kg	1.1	0.26	2	10/04/10 15:25	10/05/10 17:09	7439-92-1	
Selenium	ND	mg/kg	3.3	0.48	2	10/04/10 15:25	10/05/10 17:09	7782-49-2	
Silver	ND	mg/kg	1.5	0.073	2	10/04/10 15:25	10/05/10 17:09	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.023J**	mg/kg	0.051	0.0092	1	10/05/10 11:10	10/05/10 14:41	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**15.7**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-1-55-24 SAA **Lab ID: 6086755003** Collected: 10/01/10 14:25 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.2**	mg/kg	2.5	0.47	2	10/04/10 15:25	10/05/10 17:12	7440-38-2	
Barium	**192**	mg/kg	2.5	0.074	2	10/04/10 15:25	10/05/10 17:12	7440-39-3	
Cadmium	ND	mg/kg	1.2	0.066	2	10/04/10 15:25	10/05/10 17:12	7440-43-9	D3
Chromium	**17.5**	mg/kg	1.2	0.10	2	10/04/10 15:25	10/05/10 17:12	7440-47-3	
Lead	**13.7**	mg/kg	1.2	0.30	2	10/04/10 15:25	10/05/10 17:12	7439-92-1	
Selenium	ND	mg/kg	3.7	0.54	2	10/04/10 15:25	10/05/10 17:12	7782-49-2	
Silver	ND	mg/kg	1.7	0.081	2	10/04/10 15:25	10/05/10 17:12	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.026J**	mg/kg	0.051	0.0091	1	10/05/10 11:10	10/05/10 14:43	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**26.1**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-1-65-42 ASH **Lab ID: 6086755004** Collected: 10/01/10 14:30 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**6.4**	mg/kg	2.3	0.43	2	10/04/10 15:25	10/05/10 17:17	7440-38-2	
Barium	**199**	mg/kg	2.3	0.068	2	10/04/10 15:25	10/05/10 17:17	7440-39-3	
Cadmium	**0.36J**	mg/kg	1.1	0.061	2	10/04/10 15:25	10/05/10 17:17	7440-43-9	
Chromium	**16.8**	mg/kg	1.1	0.095	2	10/04/10 15:25	10/05/10 17:17	7440-47-3	
Lead	**30.4**	mg/kg	1.1	0.27	2	10/04/10 15:25	10/05/10 17:17	7439-92-1	
Selenium	ND	mg/kg	3.4	0.50	2	10/04/10 15:25	10/05/10 17:17	7782-49-2	D3
Silver	ND	mg/kg	1.6	0.074	2	10/04/10 15:25	10/05/10 17:17	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 18:58	7440-38-2	
Barium	**0.96J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 18:58	7440-39-3	
Cadmium	ND	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 18:58	7440-43-9	
Chromium	**0.011J**	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 18:58	7440-47-3	
Lead	ND	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 18:58	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 18:58	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 18:58	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 16:50	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.064**	mg/kg	0.048	0.0086	1	10/05/10 11:10	10/05/10 14:45	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**21.4**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-2 COMPOSITE **Lab ID: 6086755005** Collected: 10/01/10 14:35 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**22.8**	mg/kg	1.9	0.36	2	10/04/10 15:25	10/05/10 17:21	7440-38-2	
Barium	**354**	mg/kg	1.9	0.057	2	10/04/10 15:25	10/05/10 17:21	7440-39-3	
Cadmium	**3.2**	mg/kg	0.95	0.051	2	10/04/10 15:25	10/05/10 17:21	7440-43-9	
Chromium	**11.4**	mg/kg	0.95	0.080	2	10/04/10 15:25	10/05/10 17:21	7440-47-3	
Lead	**126**	mg/kg	0.95	0.23	2	10/04/10 15:25	10/05/10 17:21	7439-92-1	
Selenium	ND	mg/kg	2.8	0.42	2	10/04/10 15:25	10/05/10 17:21	7782-49-2	D3
Silver	**0.27J**	mg/kg	1.3	0.063	2	10/04/10 15:25	10/05/10 17:21	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	**0.094J**	mg/L	0.50	0.050	1	10/05/10 10:00	10/06/10 10:37	7440-38-2	
Barium	**0.62J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/06/10 10:37	7440-39-3	
Cadmium	**0.017J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/06/10 10:37	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/06/10 10:37	7440-47-3	
Lead	**0.034J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/06/10 10:37	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/06/10 10:37	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/06/10 10:37	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	**0.20J**	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 16:40	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.074**	mg/kg	0.059	0.011	1	10/05/10 11:10	10/05/10 14:46	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.2**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-2-20-36 SBA **Lab ID: 6086755006** Collected: 10/01/10 14:40 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**4.5**	mg/kg	1.9	0.36	2	10/04/10 15:25	10/05/10 17:24	7440-38-2	
Barium	**139**	mg/kg	1.9	0.057	2	10/04/10 15:25	10/05/10 17:24	7440-39-3	
Cadmium	**0.25J**	mg/kg	0.95	0.051	2	10/04/10 15:25	10/05/10 17:24	7440-43-9	
Chromium	**11.8**	mg/kg	0.95	0.080	2	10/04/10 15:25	10/05/10 17:24	7440-47-3	
Lead	**14.9**	mg/kg	0.95	0.23	2	10/04/10 15:25	10/05/10 17:24	7439-92-1	
Selenium	ND	mg/kg	2.9	0.42	2	10/04/10 15:25	10/05/10 17:24	7782-49-2	D3
Silver	ND	mg/kg	1.3	0.063	2	10/04/10 15:25	10/05/10 17:24	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.015J**	mg/kg	0.048	0.0087	1	10/05/10 11:10	10/05/10 14:48	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**11.6**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-2-55-24 SAA **Lab ID: 6086755007** Collected: 10/01/10 14:45 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**4.2**	mg/kg	1.9	0.36	2	10/04/10 15:25	10/05/10 17:28	7440-38-2	
Barium	**174**	mg/kg	1.9	0.057	2	10/04/10 15:25	10/05/10 17:28	7440-39-3	
Cadmium	**0.15J**	mg/kg	0.94	0.051	2	10/04/10 15:25	10/05/10 17:28	7440-43-9	
Chromium	**16.3**	mg/kg	0.94	0.079	2	10/04/10 15:25	10/05/10 17:28	7440-47-3	
Lead	**13.0**	mg/kg	0.94	0.23	2	10/04/10 15:25	10/05/10 17:28	7439-92-1	
Selenium	ND	mg/kg	2.8	0.42	2	10/04/10 15:25	10/05/10 17:28	7782-49-2	D3
Silver	ND	mg/kg	1.3	0.062	2	10/04/10 15:25	10/05/10 17:28	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.067**	mg/kg	0.052	0.0094	1	10/05/10 11:10	10/05/10 14:50	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.4**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-3 COMPOSITE **Lab ID: 6086755008** Collected: 10/01/10 14:50 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**20.7**	mg/kg	2.0	0.39	2	10/04/10 15:25	10/05/10 17:31	7440-38-2	
Barium	**1380**	mg/kg	2.0	0.061	2	10/04/10 15:25	10/05/10 17:31	7440-39-3	
Cadmium	**1.7**	mg/kg	1.0	0.055	2	10/04/10 15:25	10/05/10 17:31	7440-43-9	
Chromium	**11.5**	mg/kg	1.0	0.085	2	10/04/10 15:25	10/05/10 17:31	7440-47-3	
Lead	**120**	mg/kg	1.0	0.24	2	10/04/10 15:25	10/05/10 17:31	7439-92-1	
Selenium	**0.86J**	mg/kg	3.0	0.45	2	10/04/10 15:25	10/05/10 17:31	7782-49-2	
Silver	**0.24J**	mg/kg	1.4	0.067	2	10/04/10 15:25	10/05/10 17:31	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:01	7440-38-2	
Barium	**1.1**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:01	7440-39-3	
Cadmium	**0.014J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:01	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:01	7440-47-3	
Lead	**0.069J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:01	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:01	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:01	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	**0.12J**	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 16:59	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.057**	mg/kg	0.052	0.0094	1	10/05/10 11:10	10/05/10 14:52	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**17.9**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-3-25-36 SBA **Lab ID: 6086755009** Collected: 10/01/10 14:55 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.3**	mg/kg	1.8	0.34	2	10/04/10 15:25	10/05/10 17:35	7440-38-2	
Barium	**113**	mg/kg	1.8	0.053	2	10/04/10 15:25	10/05/10 17:35	7440-39-3	
Cadmium	**0.11J**	mg/kg	0.89	0.048	2	10/04/10 15:25	10/05/10 17:35	7440-43-9	
Chromium	**11.5**	mg/kg	0.89	0.075	2	10/04/10 15:25	10/05/10 17:35	7440-47-3	
Lead	**8.5**	mg/kg	0.89	0.21	2	10/04/10 15:25	10/05/10 17:35	7439-92-1	
Selenium	ND	mg/kg	2.7	0.39	2	10/04/10 15:25	10/05/10 17:35	7782-49-2	D3
Silver	ND	mg/kg	1.2	0.059	2	10/04/10 15:25	10/05/10 17:35	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	ND	mg/kg	0.048	0.0086	1	10/05/10 11:10	10/05/10 14:54	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**15.3**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-3-60-36 SAA **Lab ID: 6086755010** Collected: 10/01/10 15:00 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.2**	mg/kg	2.0	0.38	2	10/04/10 15:25	10/05/10 17:46	7440-38-2	
Barium	**184**	mg/kg	2.0	0.060	2	10/04/10 15:25	10/05/10 17:46	7440-39-3	
Cadmium	**0.092J**	mg/kg	1.0	0.054	2	10/04/10 15:25	10/05/10 17:46	7440-43-9	
Chromium	**17.7**	mg/kg	1.0	0.084	2	10/04/10 15:25	10/05/10 17:46	7440-47-3	
Lead	**14.2**	mg/kg	1.0	0.24	2	10/04/10 15:25	10/05/10 17:46	7439-92-1	
Selenium	ND	mg/kg	3.0	0.44	2	10/04/10 15:25	10/05/10 17:46	7782-49-2	D3
Silver	ND	mg/kg	1.4	0.066	2	10/04/10 15:25	10/05/10 17:46	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.025J**	mg/kg	0.050	0.0089	1	10/05/10 11:10	10/05/10 14:56	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.3**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-3-60-42 ASH **Lab ID: 6086755011** Collected: 10/01/10 15:05 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**10.7**	mg/kg	2.1	0.40	2	10/04/10 15:25	10/05/10 17:49	7440-38-2	
Barium	**1030**	mg/kg	2.1	0.063	2	10/04/10 15:25	10/05/10 17:49	7440-39-3	
Cadmium	**1.8**	mg/kg	1.1	0.057	2	10/04/10 15:25	10/05/10 17:49	7440-43-9	
Chromium	**12.6**	mg/kg	1.1	0.089	2	10/04/10 15:25	10/05/10 17:49	7440-47-3	
Lead	**57.0**	mg/kg	1.1	0.25	2	10/04/10 15:25	10/05/10 17:49	7439-92-1	
Selenium	ND	mg/kg	3.2	0.46	2	10/04/10 15:25	10/05/10 17:49	7782-49-2	D3
Silver	ND	mg/kg	1.5	0.070	2	10/04/10 15:25	10/05/10 17:49	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:05	7440-38-2	
Barium	**1.0**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:05	7440-39-3	
Cadmium	**0.019J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:05	7440-43-9	
Chromium	**0.014J**	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:05	7440-47-3	
Lead	**0.068J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:05	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:05	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:05	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:01	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.072**	mg/kg	0.046	0.0083	1	10/05/10 11:10	10/05/10 15:52	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**18.4**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-4 COMPOSITE **Lab ID: 6086755012** Collected: 10/01/10 15:10 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**22.3**	mg/kg	2.1	0.40	2	10/04/10 15:25	10/05/10 17:53	7440-38-2	
Barium	**439**	mg/kg	2.1	0.064	2	10/04/10 15:25	10/05/10 17:53	7440-39-3	
Cadmium	**3.1**	mg/kg	1.1	0.057	2	10/04/10 15:25	10/05/10 17:53	7440-43-9	
Chromium	**10.8**	mg/kg	1.1	0.089	2	10/04/10 15:25	10/05/10 17:53	7440-47-3	
Lead	**143**	mg/kg	1.1	0.26	2	10/04/10 15:25	10/05/10 17:53	7439-92-1	
Selenium	**0.73J**	mg/kg	3.2	0.47	2	10/04/10 15:25	10/05/10 17:53	7782-49-2	
Silver	**0.32J**	mg/kg	1.5	0.070	2	10/04/10 15:25	10/05/10 17:53	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:08	7440-38-2	
Barium	**0.45J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:08	7440-39-3	
Cadmium	**0.023J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:08	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:08	7440-47-3	
Lead	**0.058J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:08	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:08	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:08	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:03	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.65**	mg/kg	0.054	0.0098	1	10/05/10 11:10	10/05/10 15:54	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**19.0**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-4-65-60 ASH **Lab ID: 6086755013** Collected: 10/01/10 15:15 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**86.9**	mg/kg	2.2	0.42	2	10/04/10 15:25	10/05/10 17:56	7440-38-2	
Barium	**370**	mg/kg	2.2	0.067	2	10/04/10 15:25	10/05/10 17:56	7440-39-3	
Cadmium	**2.2**	mg/kg	1.1	0.060	2	10/04/10 15:25	10/05/10 17:56	7440-43-9	
Chromium	**13.0**	mg/kg	1.1	0.093	2	10/04/10 15:25	10/05/10 17:56	7440-47-3	
Lead	**366**	mg/kg	1.1	0.27	2	10/04/10 15:25	10/05/10 17:56	7439-92-1	
Selenium	**0.84J**	mg/kg	3.3	0.49	2	10/04/10 15:25	10/05/10 17:56	7782-49-2	
Silver	**0.94J**	mg/kg	1.6	0.073	2	10/04/10 15:25	10/05/10 17:56	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:12	7440-38-2	
Barium	**0.97J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:12	7440-39-3	
Cadmium	**0.017J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:12	7440-43-9	
Chromium	**0.015J**	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:12	7440-47-3	
Lead	**0.037J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:12	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:12	7782-49-2	
Silver	**0.011J**	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:12	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:04	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.11**	mg/kg	0.047	0.0084	1	10/05/10 11:10	10/05/10 15:56	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**19.7**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-4-65-30 SAA **Lab ID: 6086755014** Collected: 10/01/10 15:20 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.0**	mg/kg	1.9	0.35	2	10/04/10 15:25	10/05/10 18:00	7440-38-2	
Barium	**191**	mg/kg	1.9	0.056	2	10/04/10 15:25	10/05/10 18:00	7440-39-3	
Cadmium	**0.13J**	mg/kg	0.93	0.050	2	10/04/10 15:25	10/05/10 18:00	7440-43-9	
Chromium	**17.4**	mg/kg	0.93	0.078	2	10/04/10 15:25	10/05/10 18:00	7440-47-3	
Lead	**14.3**	mg/kg	0.93	0.22	2	10/04/10 15:25	10/05/10 18:00	7439-92-1	
Selenium	ND	mg/kg	2.8	0.41	2	10/04/10 15:25	10/05/10 18:00	7782-49-2	D3
Silver	ND	mg/kg	1.3	0.061	2	10/04/10 15:25	10/05/10 18:00	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.016J**	mg/kg	0.051	0.0092	1	10/05/10 11:10	10/05/10 15:58	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**18.9**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-5 COMPOSITE **Lab ID: 6086755015** Collected: 10/01/10 15:25 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**27.1**	mg/kg	2.4	0.47	2	10/04/10 15:25	10/05/10 18:03	7440-38-2	
Barium	**763**	mg/kg	2.4	0.073	2	10/04/10 15:25	10/05/10 18:03	7440-39-3	
Cadmium	**7.3**	mg/kg	1.2	0.066	2	10/04/10 15:25	10/05/10 18:03	7440-43-9	
Chromium	**12.6**	mg/kg	1.2	0.10	2	10/04/10 15:25	10/05/10 18:03	7440-47-3	
Lead	**199**	mg/kg	1.2	0.29	2	10/04/10 15:25	10/05/10 18:03	7439-92-1	
Selenium	ND	mg/kg	3.7	0.54	2	10/04/10 15:25	10/05/10 18:03	7782-49-2	D3
Silver	**0.42J**	mg/kg	1.7	0.081	2	10/04/10 15:25	10/05/10 18:03	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:16	7440-38-2	
Barium	**0.20J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:16	7440-39-3	
Cadmium	**0.031J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:16	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:16	7440-47-3	
Lead	**0.042J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:16	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:16	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:16	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:06	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.20**	mg/kg	0.050	0.0090	1	10/05/10 11:10	10/05/10 15:59	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**23.0**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-5 70-54 ASH **Lab ID: 6086755016** Collected: 10/01/10 15:30 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**21.8**	mg/kg	2.0	0.39	2	10/04/10 15:25	10/05/10 18:07	7440-38-2	
Barium	**368**	mg/kg	2.0	0.061	2	10/04/10 15:25	10/05/10 18:07	7440-39-3	
Cadmium	**15.6**	mg/kg	1.0	0.055	2	10/04/10 15:25	10/05/10 18:07	7440-43-9	
Chromium	**8.4**	mg/kg	1.0	0.086	2	10/04/10 15:25	10/05/10 18:07	7440-47-3	
Lead	**91.6**	mg/kg	1.0	0.25	2	10/04/10 15:25	10/05/10 18:07	7439-92-1	
Selenium	**1.0J**	mg/kg	3.1	0.45	2	10/04/10 15:25	10/05/10 18:07	7782-49-2	
Silver	**0.19J**	mg/kg	1.4	0.068	2	10/04/10 15:25	10/05/10 18:07	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:19	7440-38-2	
Barium	**0.38J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:19	7440-39-3	
Cadmium	**0.013J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:19	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:19	7440-47-3	
Lead	**0.024J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:19	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:19	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:19	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:08	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.074**	mg/kg	0.052	0.0094	1	10/05/10 11:10	10/05/10 16:01	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**12.8**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-5 80-24 SAA **Lab ID: 6086755017** Collected: 10/01/10 15:35 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.7**	mg/kg	1.9	0.36	2	10/04/10 15:25	10/05/10 18:10	7440-38-2	
Barium	**129**	mg/kg	1.9	0.056	2	10/04/10 15:25	10/05/10 18:10	7440-39-3	
Cadmium	ND	mg/kg	0.94	0.051	2	10/04/10 15:25	10/05/10 18:10	7440-43-9	D3
Chromium	**13.2**	mg/kg	0.94	0.079	2	10/04/10 15:25	10/05/10 18:10	7440-47-3	
Lead	**10.3**	mg/kg	0.94	0.23	2	10/04/10 15:25	10/05/10 18:10	7439-92-1	
Selenium	ND	mg/kg	2.8	0.41	2	10/04/10 15:25	10/05/10 18:10	7782-49-2	
Silver	ND	mg/kg	1.3	0.062	2	10/04/10 15:25	10/05/10 18:10	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.015J**	mg/kg	0.053	0.0096	1	10/05/10 11:10	10/05/10 16:03	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**14.9**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-6 COMPOSITE **Lab ID: 6086755018** Collected: 10/01/10 15:40 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**34.4**	mg/kg	2.2	0.41	2	10/04/10 15:25	10/05/10 18:14	7440-38-2	
Barium	**542**	mg/kg	2.2	0.065	2	10/04/10 15:25	10/05/10 18:14	7440-39-3	
Cadmium	**3.7**	mg/kg	1.1	0.058	2	10/04/10 15:25	10/05/10 18:14	7440-43-9	
Chromium	**14.5**	mg/kg	1.1	0.090	2	10/04/10 15:25	10/05/10 18:14	7440-47-3	
Lead	**334**	mg/kg	1.1	0.26	2	10/04/10 15:25	10/05/10 18:14	7439-92-1	
Selenium	**0.59J**	mg/kg	3.2	0.47	2	10/04/10 15:25	10/05/10 18:14	7782-49-2	
Silver	**0.41J**	mg/kg	1.5	0.071	2	10/04/10 15:25	10/05/10 18:14	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	**0.060J**	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:23	7440-38-2	
Barium	**0.65J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:23	7440-39-3	
Cadmium	**0.028J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:23	7440-43-9	
Chromium	**0.012J**	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:23	7440-47-3	
Lead	**0.094J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:23	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:23	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:23	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:10	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	ND	mg/kg	0.053	0.0096	1	10/05/10 11:10	10/05/10 16:05	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**19.3**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-6 15-72 SNA **Lab ID: 6086755019** Collected: 10/01/10 15:45 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.5**	mg/kg	1.8	0.34	2	10/04/10 15:25	10/05/10 18:18	7440-38-2	
Barium	**126**	mg/kg	1.8	0.053	2	10/04/10 15:25	10/05/10 18:18	7440-39-3	
Cadmium	ND	mg/kg	0.89	0.048	2	10/04/10 15:25	10/05/10 18:18	7440-43-9	D3
Chromium	**13.4**	mg/kg	0.89	0.075	2	10/04/10 15:25	10/05/10 18:18	7440-47-3	
Lead	**8.9**	mg/kg	0.89	0.21	2	10/04/10 15:25	10/05/10 18:18	7439-92-1	
Selenium	ND	mg/kg	2.7	0.39	2	10/04/10 15:25	10/05/10 18:18	7782-49-2	
Silver	ND	mg/kg	1.2	0.059	2	10/04/10 15:25	10/05/10 18:18	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	ND	mg/kg	0.047	0.0085	1	10/05/10 11:10	10/05/10 16:10	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**16.6**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-6 60-24 SAA **Lab ID: 6086755020** Collected: 10/01/10 15:50 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.4**	mg/kg	2.3	0.43	2	10/04/10 15:25	10/05/10 18:32	7440-38-2	
Barium	**198**	mg/kg	2.3	0.068	2	10/04/10 15:25	10/05/10 18:32	7440-39-3	
Cadmium	ND	mg/kg	1.1	0.061	2	10/04/10 15:25	10/05/10 18:32	7440-43-9	D3
Chromium	**20.3**	mg/kg	1.1	0.095	2	10/04/10 15:25	10/05/10 18:32	7440-47-3	
Lead	**14.4**	mg/kg	1.1	0.27	2	10/04/10 15:25	10/05/10 18:32	7439-92-1	
Selenium	ND	mg/kg	3.4	0.50	2	10/04/10 15:25	10/05/10 18:32	7782-49-2	
Silver	ND	mg/kg	1.6	0.074	2	10/04/10 15:25	10/05/10 18:32	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.014J**	mg/kg	0.051	0.0091	1	10/05/10 11:10	10/05/10 14:22	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.1**	%	0.50	0.50	1		10/04/10 00:00		

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ANALYTICAL RESULTS

Project: CFI FORT RILEY
Pace Project No.: 6086755

Sample: CFI TP-6 60-48 ASH **Lab ID: 6086755021** Collected: 10/01/10 15:55 Received: 10/04/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**26.8**	mg/kg	2.2	0.43	2	10/04/10 15:25	10/05/10 16:19	7440-38-2	
Barium	**244**	mg/kg	2.2	0.067	2	10/04/10 15:25	10/05/10 16:19	7440-39-3	
Cadmium	**1.9**	mg/kg	1.1	0.061	2	10/04/10 15:25	10/05/10 16:19	7440-43-9	
Chromium	**16.3**	mg/kg	1.1	0.094	2	10/04/10 15:25	10/05/10 16:19	7440-47-3	
Lead	**182**	mg/kg	1.1	0.27	2	10/04/10 15:25	10/05/10 16:19	7439-92-1	
Selenium	ND	mg/kg	3.4	0.49	2	10/04/10 15:25	10/05/10 16:19	7782-49-2	D3
Silver	**0.53J**	mg/kg	1.6	0.074	2	10/04/10 15:25	10/05/10 16:19	7440-22-4	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Arsenic	ND	mg/L	0.50	0.050	1	10/05/10 10:00	10/05/10 19:26	7440-38-2	
Barium	**0.98J**	mg/L	1.0	0.0094	1	10/05/10 10:00	10/05/10 19:26	7440-39-3	
Cadmium	**0.010J**	mg/L	0.050	0.0056	1	10/05/10 10:00	10/05/10 19:26	7440-43-9	
Chromium	ND	mg/L	0.10	0.010	1	10/05/10 10:00	10/05/10 19:26	7440-47-3	
Lead	**0.034J**	mg/L	0.50	0.018	1	10/05/10 10:00	10/05/10 19:26	7439-92-1	
Selenium	ND	mg/L	0.50	0.039	1	10/05/10 10:00	10/05/10 19:26	7782-49-2	
Silver	ND	mg/L	0.10	0.0099	1	10/05/10 10:00	10/05/10 19:26	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
	Leachate Method/Date: EPA 1311; 10/04/10 00:00								
Mercury	ND	ug/L	2.0	0.049	1	10/05/10 11:40	10/05/10 17:12	7439-97-6	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.13**	mg/kg	0.098	0.018	1	10/05/10 11:10	10/05/10 16:12	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**15.1**	%	0.50	0.50	1		10/04/10 00:00		

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MPRP/12409 Analysis Method: EPA 6010
QC Batch Method: EPA 3050 Analysis Description: 6010 MET
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755020

METHOD BLANK: 711834 Matrix: Solid
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755020

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/kg	ND	1.0	10/05/10 17:02	
Barium	mg/kg	0.048J	1.0	10/05/10 17:02	
Cadmium	mg/kg	ND	0.50	10/05/10 17:02	
Chromium	mg/kg	ND	0.50	10/05/10 17:02	
Lead	mg/kg	0.13J	0.50	10/05/10 17:02	
Selenium	mg/kg	ND	1.5	10/05/10 17:02	
Silver	mg/kg	ND	0.70	10/05/10 17:02	

LABORATORY CONTROL SAMPLE: 711835

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	44.2	88	80-120	
Barium	mg/kg	50	45.3	91	80-120	
Cadmium	mg/kg	50	44.8	90	80-120	
Chromium	mg/kg	50	45.8	92	80-120	
Lead	mg/kg	50	44.7	89	80-120	
Selenium	mg/kg	50	41.0	82	80-120	
Silver	mg/kg	25	22.2	89	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 711836 711837

Parameter	Units	6086755001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/kg	16.2	61.2	60.1	62.6	63.2	76	78	75-125	1	20	
Barium	mg/kg	784	61.2	60.1	1400	1480	1006	1165	75-125	6	20	M0
Cadmium	mg/kg	1.3	61.2	60.1	49.6	48.7	79	79	75-125	2	20	
Chromium	mg/kg	16.2	61.2	60.1	61.8	60.4	74	73	75-125	2	20	M0
Lead	mg/kg	76.8	61.2	60.1	134	128	93	85	75-125	5	20	
Selenium	mg/kg	0.66J	61.2	60.1	42.8	41.3	69	68	75-125	4	20	M0
Silver	mg/kg	0.11J	30.6	30	24.6	24.4	80	81	75-125	1	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MPRP/12410
QC Batch Method: EPA 3050
Analysis Method: EPA 6010
Analysis Description: 6010 MET
Associated Lab Samples: 6086755021

METHOD BLANK: 711840 Matrix: Solid
Associated Lab Samples: 6086755021

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/kg	ND	1.0	10/05/10 16:02	
Barium	mg/kg	ND	1.0	10/05/10 16:02	
Cadmium	mg/kg	ND	0.50	10/05/10 16:02	
Chromium	mg/kg	0.056J	0.50	10/05/10 16:02	
Lead	mg/kg	ND	0.50	10/05/10 16:02	
Selenium	mg/kg	ND	1.5	10/05/10 16:02	
Silver	mg/kg	0.047J	0.70	10/05/10 16:02	

LABORATORY CONTROL SAMPLE: 711841

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	43.9	88	80-120	
Barium	mg/kg	50	44.6	89	80-120	
Cadmium	mg/kg	50	45.6	91	80-120	
Chromium	mg/kg	50	46.0	92	80-120	
Lead	mg/kg	50	45.0	90	80-120	
Selenium	mg/kg	50	40.7	81	80-120	
Silver	mg/kg	25	22.2	89	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 711842 711843

Parameter	Units	6086755021 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/kg	26.8	54	56.6	72.0	75.4	84	86	75-125	5	20	
Barium	mg/kg	244	54	56.6	328	293	156	87	75-125	11	20	M0
Cadmium	mg/kg	1.9	54	56.6	44.5	46.5	79	79	75-125	4	20	
Chromium	mg/kg	16.3	54	56.6	63.3	65.7	87	87	75-125	4	20	
Lead	mg/kg	182	54	56.6	215	218	61	63	75-125	1	20	M0
Selenium	mg/kg	ND	54	56.6	37.4	39.8	69	70	75-125	6	20	M0
Silver	mg/kg	0.53J	27	28.3	23.0	24.0	83	83	75-125	4	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MPRP/12416 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET TCLP
Associated Lab Samples: 6086755001, 6086755004, 6086755008, 6086755011, 6086755012, 6086755013, 6086755015, 6086755016, 6086755018, 6086755021

METHOD BLANK: 712169 Matrix: Water
Associated Lab Samples: 6086755001, 6086755004, 6086755008, 6086755011, 6086755012, 6086755013, 6086755015, 6086755016, 6086755018, 6086755021

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/L	ND	0.50	10/05/10 18:28	
Barium	mg/L	0.022J	1.0	10/05/10 18:28	
Cadmium	mg/L	ND	0.050	10/05/10 18:28	
Chromium	mg/L	ND	0.10	10/05/10 18:28	
Lead	mg/L	0.020J	0.50	10/05/10 18:28	
Selenium	mg/L	ND	0.50	10/05/10 18:28	
Silver	mg/L	ND	0.10	10/05/10 18:28	

LABORATORY CONTROL SAMPLE: 712170

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	1	0.94	94	80-120	
Barium	mg/L	1	0.96	96	80-120	
Cadmium	mg/L	1	0.96	96	80-120	
Chromium	mg/L	1	0.96	96	80-120	
Lead	mg/L	1	0.95	95	80-120	
Selenium	mg/L	1	0.87	87	80-120	
Silver	mg/L	.5	0.48	96	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712171 712172

Parameter	Units	6086755004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/L	ND	10	10	9.3	9.3	92	92	75-125	0	20	
Barium	mg/L	0.96J	10	10	10.2	10.3	93	93	75-125	0	20	
Cadmium	mg/L	ND	10	10	9.3	9.2	93	92	75-125	1	20	
Chromium	mg/L	0.011J	10	10	9.4	9.4	94	94	75-125	0	20	
Lead	mg/L	ND	10	10	9.3	9.2	93	92	75-125	1	20	
Selenium	mg/L	ND	10	10	8.8	8.7	88	87	75-125	1	20	
Silver	mg/L	ND	5	5	4.7	4.7	94	94	75-125	0	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MPRP/12417
QC Batch Method: EPA 3010
Analysis Method: EPA 6010
Analysis Description: 6010 MET TCLP
Associated Lab Samples: 6086755005

METHOD BLANK: 712173 Matrix: Water
Associated Lab Samples: 6086755005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/L	ND	0.50	10/06/10 10:26	
Barium	mg/L	ND	1.0	10/06/10 10:26	
Cadmium	mg/L	ND	0.050	10/06/10 10:26	
Chromium	mg/L	ND	0.10	10/06/10 10:26	
Lead	mg/L	0.019J	0.50	10/06/10 10:26	
Selenium	mg/L	ND	0.50	10/06/10 10:26	
Silver	mg/L	ND	0.10	10/06/10 10:26	

LABORATORY CONTROL SAMPLE: 712174

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	1	0.94	94	80-120	
Barium	mg/L	1	0.96	96	80-120	
Cadmium	mg/L	1	0.96	96	80-120	
Chromium	mg/L	1	0.97	97	80-120	
Lead	mg/L	1	0.94	94	80-120	
Selenium	mg/L	1	0.86	86	80-120	
Silver	mg/L	.5	0.48	96	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712175 712176

Parameter	Units	6086755005 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/L	0.094J	10	10	9.5	9.5	94	94	75-125	0	20	
Barium	mg/L	0.62J	10	10	10.2	10.2	96	96	75-125	0	20	
Cadmium	mg/L	0.017J	10	10	9.4	9.5	94	95	75-125	1	20	
Chromium	mg/L	ND	10	10	9.5	9.6	95	96	75-125	1	20	
Lead	mg/L	0.034J	10	10	9.4	9.5	94	95	75-125	1	20	
Selenium	mg/L	ND	10	10	8.8	8.8	87	88	75-125	1	20	
Silver	mg/L	ND	5	5	4.8	4.8	96	97	75-125	1	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MERP/4616
QC Batch Method: EPA 7470
Analysis Method: EPA 7470
Analysis Description: 7470 Mercury TCLP
Associated Lab Samples: 6086755005

METHOD BLANK: 712161 Matrix: Water
Associated Lab Samples: 6086755005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	ug/L	0.067J	2.0	10/05/10 16:36	

LABORATORY CONTROL SAMPLE: 712162

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	5	5.1	102	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712163 712164

Parameter	Units	6086755005 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	ug/L	0.20J	15	15	15.2	15.3	100	101	75-125	1	19	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MERP/4617 Analysis Method: EPA 7470
QC Batch Method: EPA 7470 Analysis Description: 7470 Mercury TCLP
Associated Lab Samples: 6086755001, 6086755004, 6086755008, 6086755011, 6086755012, 6086755013, 6086755015, 6086755016, 6086755018, 6086755021

METHOD BLANK: 712165 Matrix: Water
Associated Lab Samples: 6086755001, 6086755004, 6086755008, 6086755011, 6086755012, 6086755013, 6086755015, 6086755016, 6086755018, 6086755021

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	ug/L	0.068J	2.0	10/05/10 16:45	

LABORATORY CONTROL SAMPLE: 712166

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	5	5.1	101	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712167 712168

Parameter	Units	6086755004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	ug/L	ND	15	15	14.2	15.2	95	101	75-125	7	19	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MERP/4612 Analysis Method: EPA 7471
QC Batch Method: EPA 7471 Analysis Description: 7471 Mercury
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755021

METHOD BLANK: 712145 Matrix: Solid
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755021

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	mg/kg	0.015J	0.050	10/05/10 14:28	

LABORATORY CONTROL SAMPLE: 712146

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	mg/kg	.5	0.51	102	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712147 712148

Parameter	Units	6086755001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	mg/kg	0.11	.52	.49	0.63	0.60	100	99	75-125	5	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: MERP/4613 Analysis Method: EPA 7471
QC Batch Method: EPA 7471 Analysis Description: 7471 Mercury
Associated Lab Samples: 6086755020

METHOD BLANK: 712149 Matrix: Solid
Associated Lab Samples: 6086755020

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	mg/kg	0.030J	0.050	10/05/10 14:19	

LABORATORY CONTROL SAMPLE: 712150

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	mg/kg	.5	0.48	95	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 712151 712152

Parameter	Units	6086755020 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	mg/kg	0.014J	.48	.49	0.48	0.50	96	98	75-125	5	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: PMST/5501 Analysis Method: ASTM D2974-87
QC Batch Method: ASTM D2974-87 Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755020

METHOD BLANK: 711771 Matrix: Solid
Associated Lab Samples: 6086755001, 6086755002, 6086755003, 6086755004, 6086755005, 6086755006, 6086755007, 6086755008, 6086755009, 6086755010, 6086755011, 6086755012, 6086755013, 6086755014, 6086755015, 6086755016, 6086755017, 6086755018, 6086755019, 6086755020

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Percent Moisture	%	ND	0.50	10/04/10 00:00	

SAMPLE DUPLICATE: 711789

Parameter	Units	6086755003 Result	Dup Result	RPD	Max RPD	Qualifiers
Percent Moisture	%	26.1	24.5	7	20	

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QUALITY CONTROL DATA

Project: CFI FORT RILEY
Pace Project No.: 6086755

QC Batch: PMST/5504
QC Batch Method: ASTM D2974-87
Analysis Method: ASTM D2974-87
Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 6086755021

METHOD BLANK: 711974 Matrix: Solid
Associated Lab Samples: 6086755021

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Percent Moisture	%	ND	0.50	10/04/10 00:00	

SAMPLE DUPLICATE: 711975

Parameter	Units	6086332013 Result	Dup Result	RPD	Max RPD	Qualifiers
Percent Moisture	%	17.3	17.1	1	20	

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QUALIFIERS

Project: CFI FORT RILEY
Pace Project No.: 6086755

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.

ANALYTE QUALIFIERS

D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.
M0	Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6086755001	CFI TP-1 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755002	CFI TP-1-30-36 SBA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755003	CFI TP-1-55-24 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755004	CFI TP-1-65-42 ASH	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755005	CFI TP-2 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755006	CFI TP-2-20-36 SBA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755007	CFI TP-2-55-24 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755008	CFI TP-3 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755009	CFI TP-3-25-36 SBA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755010	CFI TP-3-60-36 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755011	CFI TP-3-60-42 ASH	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755012	CFI TP-4 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755013	CFI TP-4-65-60 ASH	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755014	CFI TP-4-65-30 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755015	CFI TP-5 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755016	CFI TP-5 70-54 ASH	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755017	CFI TP-5 80-24 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755018	CFI TP-6 COMPOSITE	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755019	CFI TP-6 15-72 SNA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755020	CFI TP-6 60-24 SAA	EPA 3050	MPRP/12409	EPA 6010	ICP/10839
6086755021	CFI TP-6 60-48 ASH	EPA 3050	MPRP/12410	EPA 6010	ICP/10838
6086755001	CFI TP-1 COMPOSITE	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755004	CFI TP-1-65-42 ASH	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755005	CFI TP-2 COMPOSITE	EPA 3010	MPRP/12417	EPA 6010	ICP/10844
6086755008	CFI TP-3 COMPOSITE	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755011	CFI TP-3-60-42 ASH	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755012	CFI TP-4 COMPOSITE	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755013	CFI TP-4-65-60 ASH	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755015	CFI TP-5 COMPOSITE	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755016	CFI TP-5 70-54 ASH	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755018	CFI TP-6 COMPOSITE	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755021	CFI TP-6 60-48 ASH	EPA 3010	MPRP/12416	EPA 6010	ICP/10845
6086755001	CFI TP-1 COMPOSITE	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755004	CFI TP-1-65-42 ASH	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755005	CFI TP-2 COMPOSITE	EPA 7470	MERP/4616	EPA 7470	MERC/4587
6086755008	CFI TP-3 COMPOSITE	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755011	CFI TP-3-60-42 ASH	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755012	CFI TP-4 COMPOSITE	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755013	CFI TP-4-65-60 ASH	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755015	CFI TP-5 COMPOSITE	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755016	CFI TP-5 70-54 ASH	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755018	CFI TP-6 COMPOSITE	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755021	CFI TP-6 60-48 ASH	EPA 7470	MERP/4617	EPA 7470	MERC/4588
6086755001	CFI TP-1 COMPOSITE	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755002	CFI TP-1-30-36 SBA	EPA 7471	MERP/4612	EPA 7471	MERC/4584

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: CFI FORT RILEY
Pace Project No.: 6086755

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6086755003	**CFI TP-1-55-24 SAA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755004	**CFI TP-1-65-42 ASH**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755005	**CFI TP-2 COMPOSITE**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755006	**CFI TP-2-20-36 SBA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755007	**CFI TP-2-55-24 SAA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755008	**CFI TP-3 COMPOSITE**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755009	**CFI TP-3-25-36 SBA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755010	**CFI TP-3-60-36 SAA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755011	**CFI TP-3-60-42 ASH**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755012	**CFI TP-4 COMPOSITE**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755013	**CFI TP-4-65-60 ASH**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755014	**CFI TP-4-65-30 SAA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755015	**CFI TP-5 COMPOSITE**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755016	**CFI TP-5 70-54 ASH**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755017	**CFI TP-5 80-24 SAA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755018	**CFI TP-6 COMPOSITE**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755019	**CFI TP-6 15-72 SNA**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755020	**CFI TP-6 60-24 SAA**	EPA 7471	MERP/4613	EPA 7471	MERC/4583
6086755021	**CFI TP-6 60-48 ASH**	EPA 7471	MERP/4612	EPA 7471	MERC/4584
6086755001	**CFI TP-1 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755002	**CFI TP-1-30-36 SBA**	ASTM D2974-87	PMST/5501		
6086755003	**CFI TP-1-55-24 SAA**	ASTM D2974-87	PMST/5501		
6086755004	**CFI TP-1-65-42 ASH**	ASTM D2974-87	PMST/5501		
6086755005	**CFI TP-2 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755006	**CFI TP-2-20-36 SBA**	ASTM D2974-87	PMST/5501		
6086755007	**CFI TP-2-55-24 SAA**	ASTM D2974-87	PMST/5501		
6086755008	**CFI TP-3 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755009	**CFI TP-3-25-36 SBA**	ASTM D2974-87	PMST/5501		
6086755010	**CFI TP-3-60-36 SAA**	ASTM D2974-87	PMST/5501		
6086755011	**CFI TP-3-60-42 ASH**	ASTM D2974-87	PMST/5501		
6086755012	**CFI TP-4 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755013	**CFI TP-4-65-60 ASH**	ASTM D2974-87	PMST/5501		
6086755014	**CFI TP-4-65-30 SAA**	ASTM D2974-87	PMST/5501		
6086755015	**CFI TP-5 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755016	**CFI TP-5 70-54 ASH**	ASTM D2974-87	PMST/5501		
6086755017	**CFI TP-5 80-24 SAA**	ASTM D2974-87	PMST/5501		
6086755018	**CFI TP-6 COMPOSITE**	ASTM D2974-87	PMST/5501		
6086755019	**CFI TP-6 15-72 SNA**	ASTM D2974-87	PMST/5501		
6086755020	**CFI TP-6 60-24 SAA**	ASTM D2974-87	PMST/5501		
6086755021	**CFI TP-6 60-48 ASH**	ASTM D2974-87	PMST/5504		

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September 30, 2010

David Plumb
CTI and Associates, Inc.
12482 Emerson Dr.
Brighton, MI 48116

RE: Project: FORT RILEY
Pace Project No.: 6086429

Dear David Plumb:
Enclosed are the analytical results for sample(s) received by the laboratory on September 29, 2010. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jamie Slade

jamie.slade@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project: FORT RILEY
Pace Project No.: 6086429

Kansas Certification IDs
9608 Loiret Boulevard, Lenexa, KS 66219
A2LA Certification #: 2456.01
Arkansas Certification #: 05-008-0
Illinois Certification #: 001191
Iowa Certification #: 118
Kansas/NELAP Certification #: E-10116
Louisiana Certification #: 03055
Nevada Certification #: KS000212008A
Oklahoma Certification #: 9205/9935
Texas Certification #: T104704407-08-TX
Utah Certification #: 9135995665

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SAMPLE SUMMARY

Project: FORT RILEY
Pace Project No.: 6086429

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6086429001	**SP-5**	Solid	09/27/10 09:45	09/29/10 09:15
6086429002	**SP-8**	Solid	09/27/10 14:10	09/29/10 09:15
6086429003	**SP-13**	Solid	09/28/10 13:15	09/29/10 09:15

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SAMPLE ANALYTE COUNT

Project: FORT RILEY
Pace Project No.: 6086429

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6086429001	**SP-5**	EPA 6010	JDH	7
		EPA 7471	SMW	1
		ASTM D2974-87	BAC	1
6086429002	**SP-8**	EPA 6010	JDH	7
		EPA 7471	SMW	1
		ASTM D2974-87	BAC	1
6086429003	**SP-13**	EPA 6010	JDH	7
		EPA 7471	SMW	1
		ASTM D2974-87	BAC	1

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PROJECT NARRATIVE

Project: FORT RILEY
Pace Project No.: 6086429

Method: **EPA 6010**
Description: 6010 MET ICP
Client: CTI and Associates, Inc.
Date: September 30, 2010

General Information:
3 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3050 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: FORT RILEY
Pace Project No.: 6086429

Method: **EPA 7471**
Description: 7471 Mercury
Client: CTI and Associates, Inc.
Date: September 30, 2010

General Information:
3 samples were analyzed for EPA 7471. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 7471 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: MERP/4593

A matrix spike and matrix spike duplicate (MS/MSD) were performed on the following sample(s): 6086361002

M0: Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

- MS (Lab ID: 708350)
  - Mercury

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086429

Sample: SP-5 **Lab ID: 6086429001** Collected: 09/27/10 09:45 Received: 09/29/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.9**	mg/kg	1.1	0.21	1	09/29/10 12:00	09/30/10 11:14	7440-38-2	
Barium	**108**	mg/kg	1.1	0.033	1	09/29/10 12:00	09/30/10 11:14	7440-39-3	
Cadmium	**0.40J**	mg/kg	0.55	0.030	1	09/29/10 12:00	09/30/10 11:14	7440-43-9	
Chromium	**7.9**	mg/kg	0.55	0.046	1	09/29/10 12:00	09/30/10 11:14	7440-47-3	
Lead	**11.5**	mg/kg	0.55	0.13	1	09/29/10 12:00	09/30/10 11:14	7439-92-1	
Selenium	**0.25J**	mg/kg	1.7	0.24	1	09/29/10 12:00	09/30/10 11:14	7782-49-2	
Silver	**0.14J**	mg/kg	0.77	0.036	1	09/29/10 12:00	09/30/10 11:14	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**3.4**	mg/kg	0.23	0.042	5	09/30/10 10:22	09/30/10 16:34	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**19.6**	%	0.50	0.50	1		09/29/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086429

Sample: SP-8 **Lab ID: 6086429002** Collected: 09/27/10 14:10 Received: 09/29/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.7**	mg/kg	1.0	0.20	1	09/29/10 12:00	09/30/10 11:25	7440-38-2	
Barium	**88.9**	mg/kg	1.0	0.031	1	09/29/10 12:00	09/30/10 11:25	7440-39-3	
Cadmium	**0.22J**	mg/kg	0.52	0.028	1	09/29/10 12:00	09/30/10 11:25	7440-43-9	
Chromium	**8.6**	mg/kg	0.52	0.044	1	09/29/10 12:00	09/30/10 11:25	7440-47-3	
Lead	**9.7**	mg/kg	0.52	0.13	1	09/29/10 12:00	09/30/10 11:25	7439-92-1	
Selenium	ND	mg/kg	1.6	0.23	1	09/29/10 12:00	09/30/10 11:25	7782-49-2	
Silver	**0.073J**	mg/kg	0.73	0.035	1	09/29/10 12:00	09/30/10 11:25	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.39**	mg/kg	0.051	0.0092	1	09/30/10 10:22	09/30/10 16:29	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**16.4**	%	0.50	0.50	1		09/29/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086429

Sample: SP-13 **Lab ID: 6086429003** Collected: 09/28/10 13:15 Received: 09/29/10 09:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**13.8**	mg/kg	0.97	0.19	1	09/29/10 12:00	09/30/10 11:28	7440-38-2	
Barium	**109**	mg/kg	0.97	0.029	1	09/29/10 12:00	09/30/10 11:28	7440-39-3	
Cadmium	**1.9**	mg/kg	0.49	0.026	1	09/29/10 12:00	09/30/10 11:28	7440-43-9	
Chromium	**8.3**	mg/kg	0.49	0.041	1	09/29/10 12:00	09/30/10 11:28	7440-47-3	
Lead	**67.3**	mg/kg	0.49	0.12	1	09/29/10 12:00	09/30/10 11:28	7439-92-1	
Selenium	**0.66J**	mg/kg	1.5	0.21	1	09/29/10 12:00	09/30/10 11:28	7782-49-2	
Silver	**0.23J**	mg/kg	0.68	0.032	1	09/29/10 12:00	09/30/10 11:28	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.12**	mg/kg	0.052	0.0093	1	09/30/10 10:22	09/30/10 16:31	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**14.5**	%	0.50	0.50	1		09/29/10 00:00		

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086429

QC Batch: MPRP/12365 Analysis Method: EPA 6010
QC Batch Method: EPA 3050 Analysis Description: 6010 MET
Associated Lab Samples: 6086429001, 6086429002, 6086429003

METHOD BLANK: 708482 Matrix: Solid
Associated Lab Samples: 6086429001, 6086429002, 6086429003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/kg	ND	1.0	09/30/10 11:08	
Barium	mg/kg	ND	1.0	09/30/10 11:08	
Cadmium	mg/kg	ND	0.50	09/30/10 11:08	
Chromium	mg/kg	ND	0.50	09/30/10 11:08	
Lead	mg/kg	ND	0.50	09/30/10 11:08	
Selenium	mg/kg	ND	1.5	09/30/10 11:08	
Silver	mg/kg	ND	0.70	09/30/10 11:08	

LABORATORY CONTROL SAMPLE: 708483

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	47.2	94	80-120	
Barium	mg/kg	50	49.5	99	80-120	
Cadmium	mg/kg	50	46.9	94	80-120	
Chromium	mg/kg	50	51.2	102	80-120	
Lead	mg/kg	50	49.5	99	80-120	
Selenium	mg/kg	50	45.5	91	80-120	
Silver	mg/kg	25	23.9	95	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 708484 708485

Parameter	Units	6086429001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/kg	3.9	54.6	51.9	47.8	52.9	81	94	75-125	10	20	
Barium	mg/kg	108	54.6	51.9	162	154	99	88	75-125	5	20	
Cadmium	mg/kg	0.40J	54.6	51.9	44.7	42.5	81	81	75-125	5	20	
Chromium	mg/kg	7.9	54.6	51.9	55.9	53.6	88	88	75-125	4	20	
Lead	mg/kg	11.5	54.6	51.9	54.9	54.9	80	84	75-125	0	20	
Selenium	mg/kg	0.25J	54.6	51.9	42.2	39.2	77	75	75-125	7	20	
Silver	mg/kg	0.14J	27.3	25.9	22.9	22.0	84	84	75-125	4	20	

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086429

QC Batch: MERP/4593 Analysis Method: EPA 7471
QC Batch Method: EPA 7471 Analysis Description: 7471 Mercury
Associated Lab Samples: 6086429001, 6086429002, 6086429003

METHOD BLANK: 708348 Matrix: Solid
Associated Lab Samples: 6086429001, 6086429002, 6086429003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	mg/kg	ND	0.050	09/30/10 15:44	

LABORATORY CONTROL SAMPLE: 708349

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	mg/kg	.5	0.56	112	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 708350 708351

Parameter	Units	6086361002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	mg/kg	0.029J	.47	.47	0.61	0.61	126	126	75-125	0	20	M0

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086429

QC Batch: PMST/5479 Analysis Method: ASTM D2974-87
QC Batch Method: ASTM D2974-87 Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 6086429001, 6086429002, 6086429003

METHOD BLANK: 708804 Matrix: Solid
Associated Lab Samples: 6086429001, 6086429002, 6086429003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Percent Moisture	%	ND	0.50	09/29/10 00:00	

SAMPLE DUPLICATE: 708805

Parameter	Units	6086361026 Result	Dup Result	RPD	Max RPD	Qualifiers
Percent Moisture	%	21.8	22.8	4	20	

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QUALIFIERS

Project: FORT RILEY
Pace Project No.: 6086429

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.

ANALYTE QUALIFIERS

M0 Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: FORT RILEY
Pace Project No.: 6086429

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6086429001	**SP-5**	EPA 3050	MPRP/12365	EPA 6010	ICP/10794
6086429002	**SP-8**	EPA 3050	MPRP/12365	EPA 6010	ICP/10794
6086429003	**SP-13**	EPA 3050	MPRP/12365	EPA 6010	ICP/10794
6086429001	**SP-5**	EPA 7471	MERP/4593	EPA 7471	MERC/4570
6086429002	**SP-8**	EPA 7471	MERP/4593	EPA 7471	MERC/4570
6086429003	**SP-13**	EPA 7471	MERP/4593	EPA 7471	MERC/4570
6086429001	**SP-5**	ASTM D2974-87	PMST/5479		
6086429002	**SP-8**	ASTM D2974-87	PMST/5479		
6086429003	**SP-13**	ASTM D2974-87	PMST/5479		

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October 12, 2010

Robert Stenson
CTI and Associates, Inc.
1202 W. Washington Ave.
Cleveland, WI 53015

RE: Project: FORT RILEY
Pace Project No.: 6086966

Dear Robert Stenson:
Enclosed are the analytical results for sample(s) received by the laboratory on October 07, 2010. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jamie Slade

jamie.slade@pacelabs.com
Project Manager

Enclosures

cc: David Plumb, CTI and Associates, Inc.

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CERTIFICATIONS

Project: FORT RILEY
Pace Project No.: 6086966

Kansas Certification IDs
9608 Loiret Boulevard, Lenexa, KS 66219
A2LA Certification #: 2456.01
Arkansas Certification #: 05-008-0
Illinois Certification #: 001191
Iowa Certification #: 118
Kansas/NELAP Certification #: E-10116
Louisiana Certification #: 03055
Nevada Certification #: KS000212008A
Oklahoma Certification #: 9205/9935
Texas Certification #: T104704407-08-TX
Utah Certification #: 9135995665

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SAMPLE SUMMARY

Project: FORT RILEY
Pace Project No.: 6086966

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6086966001	**CFI-Q1**	Solid	10/06/10 10:30	10/07/10 09:45
6086966002	**CFI-Q2**	Solid	10/06/10 10:35	10/07/10 09:45
6086966003	**CFI-Q3**	Solid	10/06/10 10:40	10/07/10 09:45
6086966004	**CFI-Q4**	Solid	10/06/10 10:45	10/07/10 09:45
6086966005	**CFI-Q5**	Solid	10/06/10 10:50	10/07/10 09:45
6086966006	**CFI-PAD-C**	Solid	10/04/10 12:00	10/07/10 09:45

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SAMPLE ANALYTE COUNT

Project: FORT RILEY
Pace Project No.: 6086966

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6086966001	**CFI-Q1**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1
6086966002	**CFI-Q2**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1
6086966003	**CFI-Q3**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1
6086966004	**CFI-Q4**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1
6086966005	**CFI-Q5**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1
6086966006	**CFI-PAD-C**	EPA 6010	SMW	7
		EPA 7471	JDH	1
		ASTM D2974-87	TM	1

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PROJECT NARRATIVE

Project: FORT RILEY
Pace Project No.: 6086966

Method: **EPA 6010**
Description: 6010 MET ICP
Client: CTI and Associates, Inc.
Date: October 12, 2010

General Information:
6 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3050 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: FORT RILEY
Pace Project No.: 6086966

Method: **EPA 7471**
Description: 7471 Mercury
Client: CTI and Associates, Inc.
Date: October 12, 2010

General Information:
6 samples were analyzed for EPA 7471. All samples were received in acceptable condition with any exceptions noted below.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 7471 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-Q1 **Lab ID: 6086966001** Collected: 10/06/10 10:30 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**4.5**	mg/kg	1.0	0.20	1	10/11/10 15:45	10/12/10 13:57	7440-38-2	
Barium	**109**	mg/kg	1.0	0.031	1	10/11/10 15:45	10/12/10 13:57	7440-39-3	
Cadmium	**0.27J**	mg/kg	0.52	0.028	1	10/11/10 15:45	10/12/10 13:57	7440-43-9	
Chromium	**7.3**	mg/kg	0.52	0.044	1	10/11/10 15:45	10/12/10 13:57	7440-47-3	
Lead	**14.2**	mg/kg	0.52	0.13	1	10/11/10 15:45	10/12/10 13:57	7439-92-1	
Selenium	**0.30J**	mg/kg	1.6	0.23	1	10/11/10 15:45	10/12/10 13:57	7782-49-2	
Silver	**0.15J**	mg/kg	0.73	0.035	1	10/11/10 15:45	10/12/10 13:57	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.26**	mg/kg	0.046	0.0083	1	10/11/10 17:30	10/12/10 12:02	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**16.2**	%	0.50	0.50	1		10/11/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-Q2 **Lab ID: 6086966002** Collected: 10/06/10 10:35 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**4.2**	mg/kg	0.95	0.18	1	10/11/10 15:45	10/12/10 14:06	7440-38-2	
Barium	**106**	mg/kg	0.95	0.029	1	10/11/10 15:45	10/12/10 14:06	7440-39-3	
Cadmium	**0.30J**	mg/kg	0.48	0.026	1	10/11/10 15:45	10/12/10 14:06	7440-43-9	
Chromium	**7.5**	mg/kg	0.48	0.040	1	10/11/10 15:45	10/12/10 14:06	7440-47-3	
Lead	**12.6**	mg/kg	0.48	0.11	1	10/11/10 15:45	10/12/10 14:06	7439-92-1	
Selenium	**0.22J**	mg/kg	1.4	0.21	1	10/11/10 15:45	10/12/10 14:06	7782-49-2	
Silver	**0.14J**	mg/kg	0.67	0.032	1	10/11/10 15:45	10/12/10 14:06	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.070**	mg/kg	0.053	0.0095	1	10/11/10 17:30	10/12/10 12:04	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**16.2**	%	0.50	0.50	1		10/11/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-Q3 **Lab ID: 6086966003** Collected: 10/06/10 10:40 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.7**	mg/kg	1.0	0.19	1	10/11/10 15:45	10/12/10 14:10	7440-38-2	
Barium	**97.5**	mg/kg	1.0	0.031	1	10/11/10 15:45	10/12/10 14:10	7440-39-3	
Cadmium	**0.44J**	mg/kg	0.51	0.028	1	10/11/10 15:45	10/12/10 14:10	7440-43-9	
Chromium	**7.9**	mg/kg	0.51	0.043	1	10/11/10 15:45	10/12/10 14:10	7440-47-3	
Lead	**14.6**	mg/kg	0.51	0.12	1	10/11/10 15:45	10/12/10 14:10	7439-92-1	
Selenium	**0.31J**	mg/kg	1.5	0.23	1	10/11/10 15:45	10/12/10 14:10	7782-49-2	
Silver	**0.17J**	mg/kg	0.72	0.034	1	10/11/10 15:45	10/12/10 14:10	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.67**	mg/kg	0.051	0.0093	1	10/11/10 17:30	10/12/10 12:10	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**16.6**	%	0.50	0.50	1		10/11/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-Q4 **Lab ID: 6086966004** Collected: 10/06/10 10:45 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**2.9**	mg/kg	0.89	0.17	1	10/11/10 15:45	10/12/10 14:13	7440-38-2	
Barium	**90.5**	mg/kg	0.89	0.027	1	10/11/10 15:45	10/12/10 14:13	7440-39-3	
Cadmium	**0.17J**	mg/kg	0.45	0.024	1	10/11/10 15:45	10/12/10 14:13	7440-43-9	
Chromium	**7.5**	mg/kg	0.45	0.037	1	10/11/10 15:45	10/12/10 14:13	7440-47-3	
Lead	**6.9**	mg/kg	0.45	0.11	1	10/11/10 15:45	10/12/10 14:13	7439-92-1	
Selenium	**0.28J**	mg/kg	1.3	0.20	1	10/11/10 15:45	10/12/10 14:13	7782-49-2	
Silver	**0.12J**	mg/kg	0.62	0.029	1	10/11/10 15:45	10/12/10 14:13	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.010J**	mg/kg	0.045	0.0082	1	10/11/10 17:30	10/12/10 12:12	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**15.1**	%	0.50	0.50	1		10/11/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-Q5 **Lab ID: 6086966005** Collected: 10/06/10 10:50 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**5.0**	mg/kg	1.0	0.19	1	10/11/10 15:45	10/12/10 14:16	7440-38-2	
Barium	**99.7**	mg/kg	1.0	0.031	1	10/11/10 15:45	10/12/10 14:16	7440-39-3	
Cadmium	**0.40J**	mg/kg	0.51	0.028	1	10/11/10 15:45	10/12/10 14:16	7440-43-9	
Chromium	**7.7**	mg/kg	0.51	0.043	1	10/11/10 15:45	10/12/10 14:16	7440-47-3	
Lead	**16.8**	mg/kg	0.51	0.12	1	10/11/10 15:45	10/12/10 14:16	7439-92-1	
Selenium	ND	mg/kg	1.5	0.22	1	10/11/10 15:45	10/12/10 14:16	7782-49-2	
Silver	**0.16J**	mg/kg	0.71	0.034	1	10/11/10 15:45	10/12/10 14:16	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	**0.025J**	mg/kg	0.052	0.0094	1	10/11/10 17:30	10/12/10 12:14	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**22.2**	%	0.50	0.50	1		10/11/10 00:00		

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ANALYTICAL RESULTS

Project: FORT RILEY
Pace Project No.: 6086966

Sample: CFI-PAD-C **Lab ID: 6086966006** Collected: 10/04/10 12:00 Received: 10/07/10 09:45 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**3.2**	mg/kg	1.1	0.22	1	10/11/10 15:45	10/12/10 14:20	7440-38-2	
Barium	**78.5**	mg/kg	1.1	0.034	1	10/11/10 15:45	10/12/10 14:20	7440-39-3	
Cadmium	**0.13J**	mg/kg	0.57	0.031	1	10/11/10 15:45	10/12/10 14:20	7440-43-9	
Chromium	**8.0**	mg/kg	0.57	0.048	1	10/11/10 15:45	10/12/10 14:20	7440-47-3	
Lead	**7.0**	mg/kg	0.57	0.14	1	10/11/10 15:45	10/12/10 14:20	7439-92-1	
Selenium	ND	mg/kg	1.7	0.25	1	10/11/10 15:45	10/12/10 14:20	7782-49-2	
Silver	**0.13J**	mg/kg	0.80	0.038	1	10/11/10 15:45	10/12/10 14:20	7440-22-4	
7471 Mercury	Analytical Method: EPA 7471 Preparation Method: EPA 7471								
Mercury	ND	mg/kg	0.057	0.010	1	10/11/10 17:30	10/12/10 12:15	7439-97-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**20.9**	%	0.50	0.50	1		10/11/10 00:00		

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086966

QC Batch: MPRP/12471 Analysis Method: EPA 6010
QC Batch Method: EPA 3050 Analysis Description: 6010 MET
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

METHOD BLANK: 715670 Matrix: Solid
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/kg	ND	1.0	10/12/10 12:55	
Barium	mg/kg	ND	1.0	10/12/10 12:55	
Cadmium	mg/kg	ND	0.50	10/12/10 12:55	
Chromium	mg/kg	ND	0.50	10/12/10 12:55	
Lead	mg/kg	ND	0.50	10/12/10 12:55	
Selenium	mg/kg	ND	1.5	10/12/10 12:55	
Silver	mg/kg	0.053J	0.70	10/12/10 12:55	

LABORATORY CONTROL SAMPLE: 715671

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	49.5	99	80-120	
Barium	mg/kg	50	48.6	97	80-120	
Cadmium	mg/kg	50	49.5	99	80-120	
Chromium	mg/kg	50	49.3	99	80-120	
Lead	mg/kg	50	50.1	100	80-120	
Selenium	mg/kg	50	46.6	93	80-120	
Silver	mg/kg	25	23.3	93	80-120	

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086966

QC Batch: MERP/4639 Analysis Method: EPA 7471
QC Batch Method: EPA 7471 Analysis Description: 7471 Mercury
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

METHOD BLANK: 716008 Matrix: Solid
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	mg/kg	ND	0.050	10/12/10 11:34	

LABORATORY CONTROL SAMPLE: 716009

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	mg/kg	.5	0.48	96	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 716010 716011

Parameter	Units	6086924001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury	mg/kg	ND	.43	.39	0.51	0.47	110	109	75-125	9	20	

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QUALITY CONTROL DATA

Project: FORT RILEY
Pace Project No.: 6086966

QC Batch: PMST/5536 Analysis Method: ASTM D2974-87
QC Batch Method: ASTM D2974-87 Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

METHOD BLANK: 716157 Matrix: Solid
Associated Lab Samples: 6086966001, 6086966002, 6086966003, 6086966004, 6086966005, 6086966006

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Percent Moisture	%	ND	0.50	10/11/10 00:00	

SAMPLE DUPLICATE: 716158

Parameter	Units	6086593001 Result	Dup Result	RPD	Max RPD	Qualifiers
Percent Moisture	%	14.5	14.4	0	20	

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QUALIFIERS

Project: FORT RILEY
Pace Project No.: 6086966

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: FORT RILEY
Pace Project No.: 6086966

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6086966001	**CFI-Q1**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966002	**CFI-Q2**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966003	**CFI-Q3**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966004	**CFI-Q4**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966005	**CFI-Q5**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966006	**CFI-PAD-C**	EPA 3050	MPRP/12471	EPA 6010	ICP/10894
6086966001	**CFI-Q1**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966002	**CFI-Q2**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966003	**CFI-Q3**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966004	**CFI-Q4**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966005	**CFI-Q5**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966006	**CFI-PAD-C**	EPA 7471	MERP/4639	EPA 7471	MERC/4610
6086966001	**CFI-Q1**	ASTM D2974-87	PMST/5536		
6086966002	**CFI-Q2**	ASTM D2974-87	PMST/5536		
6086966003	**CFI-Q3**	ASTM D2974-87	PMST/5536		
6086966004	**CFI-Q4**	ASTM D2974-87	PMST/5536		
6086966005	**CFI-Q5**	ASTM D2974-87	PMST/5536		
6086966006	**CFI-PAD-C**	ASTM D2974-87	PMST/5536		

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Quality Control Summary Report

Camp Funston Incinerator
Fort Riley, KS

09/27/10 – 10/06/10

Prepared by

US Army Corps of Engineers
Kansas City District

PREP DATE 12/10

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1.0 Introduction

The Camp Funston Incinerator is located in the Camp Funston cantonment area of Ft. Riley, KS. The site was a functioning incinerator during World War I, when it appears the common method of disposing of ash was to tip it over the edge of the nearby escarpment . Sampling was conducted to determine the nature, extent and depth of the resulting ash accumulation.

2.0 Sampling

Soil samples were collected from 30 sites at the Camp Funston Incinerator between 09/27/10 and 10/6/10. Eleven liquid samples were collected at the same time. Samples were analyzed for RCRA Metals (As, Ba, Cd, Cr, Hg, Pd, Se & Ag) by the methods indicated in Table 1. Methods performed at each location are given in Table 2.

3.0 Data Quality Evaluation

Holding time.

Table 3 indicates the holding time for each sample/method. Holding time for 6010b is 6 months and 28 days for Hg by 7470/7471. All samples were analyzed within the method holding time.

Sample Preservation

Samples were collected in pre-preserved bottles containing HNO_3 as required by the methods.

Method Blanks

Results of Method Blank analysis are given in Table 4. All detections in Method Blanks were less than the Reporting Limit, no qualifiers were assigned due to blank contamination.

Laboratory Control Sample

Table 5 presents the LCS recoveries for each compound/method in each SDG. All LCS samples were recovered within the prescribed limits.

Matrix Spike/Matrix Spike Duplicate

MS/MSD recoveries are shown in Table 6. All recoveries were within the limits set.

4.0 Results

Detected Analytes

In Table 7 and Table 8 are given the result of analytes detected for both solid and liquid samples. Sample between the MDL and RL were J flagged.

Complete Data Tables

Complete data tables are presented in Table 9 and Table 10, Non-detections are represented by the Reporting Limit reported in the analysis results.

Table 1: Methods	
Method	**Description**
6010B	Metals by Inductively Coupled Plasma-Atomic Emission
7470A	Mercury in Liquid Waste by Manual Cold Vapor Technology
7471A	Mercury in Solid Waste by Manual Cold Vapor Technology

Table 2: Samples Collected					
SDG	**Sample_ID**	**Date**	**6010**	**7470**	**7471**
6086429	SP-5	09/27/10	X		X
6086429	SP-5 RE	09/27/10			X
6086429	SP-8	09/27/10	X		X
6086429	SP-13	09/28/10	X		X
6086755	CFI TP-1 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-1-30-36 SBA	10/01/10	X		X
6086755	CFI TP-1-55-24 SAA	10/01/10	X		X
6086755	CFI TP-1-65-42 ASH	10/01/10	X	X	X
6086755	CFI TP-2 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-2-20-36 SBA	10/01/10	X		X
6086755	CFI TP-2-55-24 SAA	10/01/10	X		X
6086755	CFI TP-3 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-3-25-36 SBA	10/01/10	X		X
6086755	CFI TP-3-60-36 SAA	10/01/10	X		X
6086755	CFI TP-3-60-42 ASH	10/01/10	X	X	X
6086755	CFI TP-4 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-4-65-60 ASH	10/01/10	X	X	X
6086755	CFI TP-4-65-30 SAA	10/01/10	X		X
6086755	CFI TP-5 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-5 70-54 ASH	10/01/10	X	X	X
6086755	CFI TP-5 80-24 SAA	10/01/10	X		X
6086755	CFI TP-6 COMPOSITE	10/01/10	X	X	X
6086755	CFI TP-6 15-72 SNA	10/01/10	X		X
6086755	CFI TP-6 60-24 SAA	10/01/10	X		X
6086755	CFI TP-6 60-48 ASH	10/01/10	X	X	X
6086966	CFI-PAD-C	10/04/10	X		X
6086966	CFI-Q1	10/06/10	X		X
6086966	CFI-Q2	10/06/10	X		X
6086966	CFI-Q3	10/06/10	X		X
6086966	CFI-Q4	10/06/10	X		X
6086966	CFI-Q5	10/06/10	X		X

Table 3: Holding Times							
Sample	Collection Date	EPA 6010		EPA 7470		EPA 7471	
		Anal Date	HT	Anal Date	HT	Anal Date	HT
SP-5	09/27/10	9/30/10	2			9/30/10	2
SP-5 RE	09/27/10					40472	23
SP-8	09/27/10	9/30/10	2			9/30/10	2
SP-13	09/28/10	9/30/10	1			9/30/10	1
CFI TP-1 COMPOSITE	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-1-30-36 SBA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-1-55-24 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-1-65-42 ASH	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-2 COMPOSITE	10/01/10	10/6/10	4	10/5/10	3	10/5/10	3
CFI TP-2-20-36 SBA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-2-55-24 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-3 COMPOSITE	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-3-25-36 SBA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-3-60-36 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-3-60-42 ASH	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-4 COMPOSITE	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-4-65-30 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-4-65-60 ASH	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-5 70-54 ASH	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-5 80-24 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-5 COMPOSITE	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-6 15-72 SNA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-6 60-24 SAA	10/01/10	10/5/10	3			10/5/10	3
CFI TP-6 60-48 ASH	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI TP-6 COMPOSITE	10/01/10	10/5/10	3	10/5/10	3	10/5/10	3
CFI-PAD-C	10/04/10	10/12/10	7			10/12/10	7
CFI-Q1	10/06/10	10/12/10	5			10/12/10	5
CFI-Q2	10/06/10	10/12/10	5			10/12/10	5
CFI-Q3	10/06/10	10/12/10	5			10/12/10	5
CFI-Q4	10/06/10	10/12/10	5			10/12/10	5
CFI-Q5	10/06/10	10/12/10	5			10/12/10	5

Table 4: Method Blanks			
Compound	**6086429**	**6086755**	**6086966**
Arsenic	0.19 U	0.19 U	0.19 U
Barium	0.030 U	0.048 J	0.030 U
Cadmium	0.027 U	0.027 U	0.027 U
Chromium	0.042 U	0.056 J	0.042 U
Lead	0.12 U	0.13 J	0.12 U
Mercury		0.068 J	
Selenium	0.22 U	0.22 U	0.22 U
Silver	0.033 U	0.047 J	0.053 J

Table 5: LCS Recoveries									
	6086429			**6086755**			**6086966**		
Compound	**6010**	**7470**	**7471**	**6010**	**7470**	**7471**	**6010**	**7470**	**7471**
Arsenic	94%			88%			99%		
Barium	99%			89%			97%		
Cadmium	94%			90%			99%		
Chromium	102%			92%			99%		
Lead	99%			89%			100%		
Mercury		100%	100%		101%	101%		96%	96%
Selenium	91%			81%			93%		
Silver	95%			89%			93%		

Table 6: MS/MSD Recoveries							
		EPA 6010		EPA 7470		EPA 7471	
SDG	Compound	MS-MSD	RPD	MS-MSD	RPD	MS-MSD	RPD
6086429	Arsenic	81% - 94%	14.90%				
	Barium	99% - 88%	11.80%				
	Cadmium	81% - 81%	0%				
	Chromium	88% - 88%	0%				
	Lead	80% - 84%	4.88%				
	Mercury			126% - 126%	0%	126% - 126%	0%
	Selenium	77% - 75%	2.63%				
	Silver	84% - 84%	0%				
6086755	Arsenic	76% - 78%	2.60%				
	Barium	1006% - 1165%	14.60%				
	Cadmium	79% - 79%	0%				
	Chromium	74% - 73%	1.36%				
	Lead	61% - 63%	3.23%				
	Mercury			100% - 101%	1.00%	100% - 101%	1.00%
	Selenium	69% - 68%	1.46%				
	Silver	80% - 81%	1.24%				
6086966	Mercury			110% - 109%	0.91%	110% - 109%	0.91%

Table 7: Detections Water Samples																				
Sample_ID	Date	Arsenic			Barium			Cadmium			Chromium			Lead			Silver		
CFI TP-1 COMPOSITE	10/01/10				1.6		mg/L							0.1	J	mg/L			
CFI TP-1-65-42 ASH	10/01/10				0.96	J	mg/L				0.011	J	mg/L						
CFI TP-2 COMPOSITE	10/01/10	0.094	J	mg/L	0.62	J	mg/L	0.017	J	mg/L				0.034	J	mg/L			
CFI TP-3 COMPOSITE	10/01/10				1.1		mg/L	0.014	J	mg/L				0.069	J	mg/L			
CFI TP-3-60-42 ASH	10/01/10				1		mg/L	0.019	J	mg/L	0.014	J	mg/L	0.068	J	mg/L			
CFI TP-4 COMPOSITE	10/01/10				0.45	J	mg/L	0.023	J	mg/L				0.058	J	mg/L			
CFI TP-4-65-60 ASH	10/01/10				0.97	J	mg/L	0.017	J	mg/L	0.015	J	mg/L	0.037	J	mg/L	0.011	J	mg/L
CFI TP-5 70-54 ASH	10/01/10				0.38	J	mg/L	0.013	J	mg/L				0.024	J	mg/L			
CFI TP-5 COMPOSITE	10/01/10				0.2	J	mg/L	0.031	J	mg/L				0.042	J	mg/L			
CFI TP-6 60-48 ASH	10/01/10				0.98	J	mg/L	0.01	J	mg/L				0.034	J	mg/L			
CFI TP-6 COMPOSITE	10/01/10	0.06	J	mg/L	0.65	J	mg/L	0.028	J	mg/L	0.012	J	mg/L	0.094	J	mg/L			

Table 8: Detections Solid Samples													
Sample_ID	Date	Arsenic			Barium			Cadmium			Chromium		
SP-13	09/28/10	13.8		mg/kg	109		mg/kg	1.9		mg/kg	8.3		mg/kg
SP-5	09/27/10	3.9		mg/kg	108		mg/kg	0.4	J	mg/kg	7.9		mg/kg
SP-5 RE	09/27/10												
SP-8	09/27/10	3.7		mg/kg	88.9		mg/kg	0.22	J	mg/kg	8.6		mg/kg
CFI TP-1 COMPOSITE	10/01/10	16.2		mg/kg	784		mg/kg	1.3		mg/kg	16.2		mg/kg
CFI TP-1-30-36 SBA	10/01/10	5		mg/kg	156		mg/kg				13.9		mg/kg
CFI TP-1-55-24 SAA	10/01/10	5.2		mg/kg	192		mg/kg				17.5		mg/kg
CFI TP-1-65-42 ASH	10/01/10	6.4		mg/kg	199		mg/kg	0.36	J	mg/kg	16.8		mg/kg
CFI TP-2 COMPOSITE	10/01/10	22.8		mg/kg	354		mg/kg	3.2		mg/kg	11.4		mg/kg
CFI TP-2-20-36 SBA	10/01/10	4.5		mg/kg	139		mg/kg	0.25	J	mg/kg	11.8		mg/kg
CFI TP-2-55-24 SAA	10/01/10	4.2		mg/kg	174		mg/kg	0.15	J	mg/kg	16.3		mg/kg
CFI TP-3 COMPOSITE	10/01/10	20.7		mg/kg	1380		mg/kg	1.7		mg/kg	11.5		mg/kg
CFI TP-3-25-36 SBA	10/01/10	3.3		mg/kg	113		mg/kg	0.11	J	mg/kg	11.5		mg/kg
CFI TP-3-60-36 SAA	10/01/10	5.2		mg/kg	184		mg/kg	0.092	J	mg/kg	17.7		mg/kg
CFI TP-3-60-42 ASH	10/01/10	10.7		mg/kg	1030		mg/kg	1.8		mg/kg	12.6		mg/kg
CFI TP-4 COMPOSITE	10/01/10	22.3		mg/kg	439		mg/kg	3.1		mg/kg	10.8		mg/kg
CFI TP-4-65-30 SAA	10/01/10	5		mg/kg	191		mg/kg	0.13	J	mg/kg	17.4		mg/kg
CFI TP-4-65-60 ASH	10/01/10	86.9		mg/kg	370		mg/kg	2.2		mg/kg	13		mg/kg
CFI TP-5 70-54 ASH	10/01/10	21.8		mg/kg	368		mg/kg	15.6		mg/kg	8.4		mg/kg
CFI TP-5 80-24 SAA	10/01/10	3.7		mg/kg	129		mg/kg				13.2		mg/kg
CFI TP-5 COMPOSITE	10/01/10	27.1		mg/kg	763		mg/kg	7.3		mg/kg	12.6		mg/kg
CFI TP-6 15-72 SNA	10/01/10	3.5		mg/kg	126		mg/kg				13.4		mg/kg
CFI TP-6 60-24 SAA	10/01/10	5.4		mg/kg	198		mg/kg				20.3		mg/kg
CFI TP-6 60-48 ASH	10/01/10	26.8		mg/kg	244		mg/kg	1.9		mg/kg	16.3		mg/kg
CFI TP-6 COMPOSITE	10/01/10	34.4		mg/kg	542		mg/kg	3.7		mg/kg	14.5		mg/kg
CFI-PAD-C	10/04/10	3.2		mg/kg	78.5		mg/kg	0.13	J	mg/kg	8		mg/kg
CFI-Q1	10/06/10	4.5		mg/kg	109		mg/kg	0.27	J	mg/kg	7.3		mg/kg
CFI-Q2	10/06/10	4.2		mg/kg	106		mg/kg	0.3	J	mg/kg	7.5		mg/kg
CFI-Q3	10/06/10	3.7		mg/kg	97.5		mg/kg	0.44	J	mg/kg	7.9		mg/kg
CFI-Q4	10/06/10	2.9		mg/kg	90.5		mg/kg	0.17	J	mg/kg	7.5		mg/kg
CFI-Q5	10/06/10	5		mg/kg	99.7		mg/kg	0.4	J	mg/kg	7.7		mg/kg

Table 8: Detections Solid Samples													
Sample_ID	Date	Lead			Mercury			Selenium			Silver		
SP-13	09/28/10	67.3		mg/kg	0.12		mg/kg	0.66	J	mg/kg	0.23	J	mg/kg
SP-5	09/27/10	11.5		mg/kg	3.4		mg/kg	0.25	J	mg/kg	0.14	J	mg/kg
SP-5 RE	09/27/10				2.6		mg/kg						
SP-8	09/27/10	9.7		mg/kg	0.39		mg/kg				0.073	J	mg/kg
CFI TP-1 COMPOSITE	10/01/10	76.8		mg/kg	0.11		mg/kg	0.66	J	mg/kg	0.11	J	mg/kg
CFI TP-1-30-36 SBA	10/01/10	44		mg/kg	0.023	J	mg/kg						
CFI TP-1-55-24 SAA	10/01/10	13.7		mg/kg	0.026	J	mg/kg						
CFI TP-1-65-42 ASH	10/01/10	30.4		mg/kg	0.064		mg/kg						
CFI TP-2 COMPOSITE	10/01/10	126		mg/kg	0.074		mg/kg				0.27	J	mg/kg
CFI TP-2-20-36 SBA	10/01/10	14.9		mg/kg	0.015	J	mg/kg						
CFI TP-2-55-24 SAA	10/01/10	13		mg/kg	0.067		mg/kg						
CFI TP-3 COMPOSITE	10/01/10	120		mg/kg	0.057		mg/kg	0.86	J	mg/kg	0.24	J	mg/kg
CFI TP-3-25-36 SBA	10/01/10	8.5		mg/kg									
CFI TP-3-60-36 SAA	10/01/10	14.2		mg/kg	0.025	J	mg/kg						
CFI TP-3-60-42 ASH	10/01/10	57		mg/kg	0.072		mg/kg						
CFI TP-4 COMPOSITE	10/01/10	143		mg/kg	0.65		mg/kg	0.73	J	mg/kg	0.32	J	mg/kg
CFI TP-4-65-30 SAA	10/01/10	14.3		mg/kg	0.016	J	mg/kg						
CFI TP-4-65-60 ASH	10/01/10	366		mg/kg	0.11		mg/kg	0.84	J	mg/kg	0.94	J	mg/kg
CFI TP-5 70-54 ASH	10/01/10	91.6		mg/kg	0.074		mg/kg	1	J	mg/kg	0.19	J	mg/kg
CFI TP-5 80-24 SAA	10/01/10	10.3		mg/kg	0.015	J	mg/kg						
CFI TP-5 COMPOSITE	10/01/10	199		mg/kg	0.2		mg/kg				0.42	J	mg/kg
CFI TP-6 15-72 SNA	10/01/10	8.9		mg/kg									
CFI TP-6 60-24 SAA	10/01/10	14.4		mg/kg	0.014	J	mg/kg						
CFI TP-6 60-48 ASH	10/01/10	182		mg/kg	0.13		mg/kg				0.53	J	mg/kg
CFI TP-6 COMPOSITE	10/01/10	334		mg/kg				0.59	J	mg/kg	0.41	J	mg/kg
CFI-PAD-C	10/04/10	7		mg/kg							0.13	J	mg/kg
CFI-Q1	10/06/10	14.2		mg/kg	0.26		mg/kg	0.3	J	mg/kg	0.15	J	mg/kg
CFI-Q2	10/06/10	12.6		mg/kg	0.07		mg/kg	0.22	J	mg/kg	0.14	J	mg/kg
CFI-Q3	10/06/10	14.6		mg/kg	0.67		mg/kg	0.31	J	mg/kg	0.17	J	mg/kg
CFI-Q4	10/06/10	6.9		mg/kg	0.01	J	mg/kg	0.28	J	mg/kg	0.12	J	mg/kg
CFI-Q5	10/06/10	16.8		mg/kg	0.025	J	mg/kg				0.16	J	mg/kg

Table 9: All Data Water Samples												
Sample_ID	Arsenic			Barium			Cadmium			Chromium		
CFI TP-1 COMPOSITE	0.5	U	mg/L	1.6		mg/L	0.05	U	mg/L	0.1	U	mg/L
CFI TP-1-65-42 ASH	0.5	U	mg/L	0.96	J	mg/L	0.05	U	mg/L	0.011	J	mg/L
CFI TP-2 COMPOSITE	0.094	J	mg/L	0.62	J	mg/L	0.017	J	mg/L	0.1	U	mg/L
CFI TP-3 COMPOSITE	0.5	U	mg/L	1.1		mg/L	0.014	J	mg/L	0.1	U	mg/L
CFI TP-3-60-42 ASH	0.5	U	mg/L	1		mg/L	0.019	J	mg/L	0.014	J	mg/L
CFI TP-4 COMPOSITE	0.5	U	mg/L	0.45	J	mg/L	0.023	J	mg/L	0.1	U	mg/L
CFI TP-4-65-60 ASH	0.5	U	mg/L	0.97	J	mg/L	0.017	J	mg/L	0.015	J	mg/L
CFI TP-5 70-54 ASH	0.5	U	mg/L	0.38	J	mg/L	0.013	J	mg/L	0.1	U	mg/L
CFI TP-5 COMPOSITE	0.5	U	mg/L	0.2	J	mg/L	0.031	J	mg/L	0.1	U	mg/L
CFI TP-6 60-48 ASH	0.5	U	mg/L	0.98	J	mg/L	0.01	J	mg/L	0.1	U	mg/L
CFI TP-6 COMPOSITE	0.06	J	mg/L	0.65	J	mg/L	0.028	J	mg/L	0.012	J	mg/L

Table 9: All Data Water Samples									
Sample_ID	Lead			Selenium			Silver		
CFI TP-1 COMPOSITE	0.1	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-1-65-42 ASH	0.5	U	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-2 COMPOSITE	0.034	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-3 COMPOSITE	0.069	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-3-60-42 ASH	0.068	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-4 COMPOSITE	0.058	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-4-65-60 ASH	0.037	J	mg/L	0.5	U	mg/L	0.011	J	mg/L
CFI TP-5 70-54 ASH	0.024	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-5 COMPOSITE	0.042	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-6 60-48 ASH	0.034	J	mg/L	0.5	U	mg/L	0.1	U	mg/L
CFI TP-6 COMPOSITE	0.094	J	mg/L	0.5	U	mg/L	0.1	U	mg/L

Table 10:All Data Solid Samples												
Sample_ID	Arsenic			Barium			Cadmium			Chromium		
SP-13	13.8		mg/kg	109		mg/kg	1.9		mg/kg	8.3		mg/kg
SP-5	3.9		mg/kg	108		mg/kg	0.4	J	mg/kg	7.9		mg/kg
SP-5 RE												
SP-8	3.7		mg/kg	88.9		mg/kg	0.22	J	mg/kg	8.6		mg/kg
CFI TP-1 COMPOSITE	16.2		mg/kg	784		mg/kg	1.3		mg/kg	16.2		mg/kg
CFI TP-1-30-36 SBA	5		mg/kg	156		mg/kg	1.1	U	mg/kg	13.9		mg/kg
CFI TP-1-55-24 SAA	5.2		mg/kg	192		mg/kg	1.2	U	mg/kg	17.5		mg/kg
CFI TP-1-65-42 ASH	6.4		mg/kg	199		mg/kg	0.36	J	mg/kg	16.8		mg/kg
CFI TP-2 COMPOSITE	22.8		mg/kg	354		mg/kg	3.2		mg/kg	11.4		mg/kg
CFI TP-2-20-36 SBA	4.5		mg/kg	139		mg/kg	0.25	J	mg/kg	11.8		mg/kg
CFI TP-2-55-24 SAA	4.2		mg/kg	174		mg/kg	0.15	J	mg/kg	16.3		mg/kg
CFI TP-3 COMPOSITE	20.7		mg/kg	1380		mg/kg	1.7		mg/kg	11.5		mg/kg
CFI TP-3-25-36 SBA	3.3		mg/kg	113		mg/kg	0.11	J	mg/kg	11.5		mg/kg
CFI TP-3-60-36 SAA	5.2		mg/kg	184		mg/kg	0.092	J	mg/kg	17.7		mg/kg
CFI TP-3-60-42 ASH	10.7		mg/kg	1030		mg/kg	1.8		mg/kg	12.6		mg/kg
CFI TP-4 COMPOSITE	22.3		mg/kg	439		mg/kg	3.1		mg/kg	10.8		mg/kg
CFI TP-4-65-30 SAA	5		mg/kg	191		mg/kg	0.13	J	mg/kg	17.4		mg/kg
CFI TP-4-65-60 ASH	86.9		mg/kg	370		mg/kg	2.2		mg/kg	13		mg/kg
CFI TP-5 70-54 ASH	21.8		mg/kg	368		mg/kg	15.6		mg/kg	8.4		mg/kg
CFI TP-5 80-24 SAA	3.7		mg/kg	129		mg/kg	0.94	U	mg/kg	13.2		mg/kg
CFI TP-5 COMPOSITE	27.1		mg/kg	763		mg/kg	7.3		mg/kg	12.6		mg/kg
CFI TP-6 15-72 SNA	3.5		mg/kg	126		mg/kg	0.89	U	mg/kg	13.4		mg/kg
CFI TP-6 60-24 SAA	5.4		mg/kg	198		mg/kg	1.1	U	mg/kg	20.3		mg/kg
CFI TP-6 60-48 ASH	26.8		mg/kg	244		mg/kg	1.9		mg/kg	16.3		mg/kg
CFI TP-6 COMPOSITE	34.4		mg/kg	542		mg/kg	3.7		mg/kg	14.5		mg/kg
CFI-PAD-C	3.2		mg/kg	78.5		mg/kg	0.13	J	mg/kg	8		mg/kg
CFI-Q1	4.5		mg/kg	109		mg/kg	0.27	J	mg/kg	7.3		mg/kg
CFI-Q2	4.2		mg/kg	106		mg/kg	0.3	J	mg/kg	7.5		mg/kg
CFI-Q3	3.7		mg/kg	97.5		mg/kg	0.44	J	mg/kg	7.9		mg/kg
CFI-Q4	2.9		mg/kg	90.5		mg/kg	0.17	J	mg/kg	7.5		mg/kg
CFI-Q5	5		mg/kg	99.7		mg/kg	0.4	J	mg/kg	7.7		mg/kg

Table 10:All Data Solid Samples												
Client_Sample_ID	Lead			Mercury			Selenium			Silver		
SP-13	67.3		mg/kg	0.12		mg/kg	0.66	J	mg/kg	0.23	J	mg/kg
SP-5	11.5		mg/kg	3.4		mg/kg	0.25	J	mg/kg	0.14	J	mg/kg
SP-5 RE				2.6		mg/kg						
SP-8	9.7		mg/kg	0.39		mg/kg	1.6	U	mg/kg	0.07	J	mg/kg
CFI TP-1 COMPOSITE	76.8		mg/kg	0.11		mg/kg	0.66	J	mg/kg	0.11	J	mg/kg
CFI TP-1-30-36 SBA	44		mg/kg	0.023	J	mg/kg	3.3	U	mg/kg	1.5	U	mg/kg
CFI TP-1-55-24 SAA	13.7		mg/kg	0.026	J	mg/kg	3.7	U	mg/kg	1.7	U	mg/kg
CFI TP-1-65-42 ASH	30.4		mg/kg	0.064		mg/kg	3.4	U	mg/kg	1.6	U	mg/kg
CFI TP-2 COMPOSITE	126		mg/kg	0.074		mg/kg	2.8	U	mg/kg	0.27	J	mg/kg
CFI TP-2-20-36 SBA	14.9		mg/kg	0.015	J	mg/kg	2.9	U	mg/kg	1.3	U	mg/kg
CFI TP-2-55-24 SAA	13		mg/kg	0.067		mg/kg	2.8	U	mg/kg	1.3	U	mg/kg
CFI TP-3 COMPOSITE	120		mg/kg	0.057		mg/kg	0.86	J	mg/kg	0.24	J	mg/kg
CFI TP-3-25-36 SBA	8.5		mg/kg	0.048	U	mg/kg	2.7	U	mg/kg	1.2	U	mg/kg
CFI TP-3-60-36 SAA	14.2		mg/kg	0.025	J	mg/kg	3	U	mg/kg	1.4	U	mg/kg
CFI TP-3-60-42 ASH	57		mg/kg	0.072		mg/kg	3.2	U	mg/kg	1.5	U	mg/kg
CFI TP-4 COMPOSITE	143		mg/kg	0.65		mg/kg	0.73	J	mg/kg	0.32	J	mg/kg
CFI TP-4-65-30 SAA	14.3		mg/kg	0.016	J	mg/kg	2.8	U	mg/kg	1.3	U	mg/kg
CFI TP-4-65-60 ASH	366		mg/kg	0.11		mg/kg	0.84	J	mg/kg	0.94	J	mg/kg
CFI TP-5 70-54 ASH	91.6		mg/kg	0.074		mg/kg	1	J	mg/kg	0.19	J	mg/kg
CFI TP-5 80-24 SAA	10.3		mg/kg	0.015	J	mg/kg	2.8	U	mg/kg	1.3	U	mg/kg
CFI TP-5 COMPOSITE	199		mg/kg	0.2		mg/kg	3.7	U	mg/kg	0.42	J	mg/kg
CFI TP-6 15-72 SNA	8.9		mg/kg	0.047	U	mg/kg	2.7	U	mg/kg	1.2	U	mg/kg
CFI TP-6 60-24 SAA	14.4		mg/kg	0.014	J	mg/kg	3.4	U	mg/kg	1.6	U	mg/kg
CFI TP-6 60-48 ASH	182		mg/kg	0.13		mg/kg	3.4	U	mg/kg	0.53	J	mg/kg
CFI TP-6 COMPOSITE	334		mg/kg	0.053	U	mg/kg	0.59	J	mg/kg	0.41	J	mg/kg
CFI-PAD-C	7		mg/kg	0.057	U	mg/kg	1.7	U	mg/kg	0.13	J	mg/kg
CFI-Q1	14.2		mg/kg	0.26		mg/kg	0.3	J	mg/kg	0.15	J	mg/kg
CFI-Q2	12.6		mg/kg	0.07		mg/kg	0.22	J	mg/kg	0.14	J	mg/kg
CFI-Q3	14.6		mg/kg	0.67		mg/kg	0.31	J	mg/kg	0.17	J	mg/kg
CFI-Q4	6.9		mg/kg	0.01	J	mg/kg	0.28	J	mg/kg	0.12	J	mg/kg
CFI-Q5	16.8		mg/kg	0.025	J	mg/kg	1.5	U	mg/kg	0.16	J	mg/kg

APPENDIX B

Physical and Chemical Characteristics of Constituents

APPENDIX B

FINAL

PHYSICAL AND CHEMICL CHARACTERISTICS OF CONSTITUENTS FOR THE WWI INCINERATOR, NW CAMP FUNSTON (CFI) – OPERABLE UNIT 007 AT FORT RILEY, KANSAS

October 23, 2013

Prepared for

U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Prepared by

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APPENDIX B
PHYSICAL AND CHEMICAL CHARACTERISTICS OF CONSTITUENTS

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LIST OF ACRONYMS AND ABBREVIATIONS

$atm\text{-}m^3$	atmospheres-cubic meters/mole
C	current chemical concentration
C_o	original chemical concentration
CFI	WWI Incinerator, NW Camp Funston
$h_{1/2}$	half-life
k	decay constant
K_{oc}	organic carbon-water partitioning coefficient
K_{ow}	octanol-water partitioning coefficient
mg/L	milligrams per liter
mmHg	millimeters of mercury
RI/FS	Remedial Investigation/Feasibility Study
RSL	Regional Screening Level
t	time
WP	Work Plan
USEPA	United States Environmental Protection Agency

* * * * *

APPENDIX B
PHYSICAL AND CHEMICAL CHARACTERISTICS OF CONSTITUENTS

B.1 INTRODUCTION

Contaminant behavior in the environment is an important determinant of exposure pathways and concentrations. The behavior of contaminants is a function of the physical and chemical properties specific to the contaminants, as well as characteristics of the matrix, or matrices, in which the contaminant exists or moves. Important contaminant-specific physiochemical properties include molecular weight, water solubility, vapor pressure, volatility (Henry's Law constant), octanol-water partitioning coefficient (K_{ow}), organic carbon-water partitioning coefficient (K_{oc}), air diffusion coefficient, and half-life ($t_{1/2}$). These chemical and physical properties affect the degree of completion and rate of certain chemical reactions, thereby determining the fate of a contaminant in the subsurface. All chemical and physical properties used will be acquired from the USEPA's *Regional Screening Levels for Chemical Contaminants at Superfund Sites, Chemical-Specific Parameters Supporting Table* (USEPA, 2013). USEPA RSL tables are provided in Appendix C of the *Remedial Investigation/Feasibility Study (RI/FS) Work Plan (WP) for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*.

B.2 WATER SOLUBILITY

Water solubility, often referred to only as "solubility," refers to the maximum concentration of a chemical that will dissolve in a given amount of pure water. The solubility of a contaminant is important to understanding its ability to migrate in the environment. The solubility of a chemical is a major determinant of how a contaminant will be affected by infiltrating and flowing water and, thereby how quickly the contaminant will migrate through the subsurface. Compounds with water solubilities greater than 1000 milligrams per liter (mg/L) are not expected to migrate. Highly water-soluble chemicals are less strongly adsorbed to soil and can be readily leached to groundwater. Additionally, highly water-soluble chemicals tend to volatilize less from water and be more biodegradable. Water solubility affects hydrolysis, photolysis, and biodegradation rates. In general, as solubility increases, mobility and biodegradation increase while adsorption, persistence and bioaccumulation decrease (Ney, 1990).

B.3 VAPOR PRESSURE

Vapor pressure is a measure of the volatility of a chemical in its pure state and is an important determination of the rate of volatilization from contaminated soils and waters. As vapor pressure increases, volatilization increases, and water solubility and adsorption decrease. Compounds with vapor

pressures greater than 0.01 millimeters of mercury (mmHg) have high volatilities, and compounds with vapor pressures less than 1^{-06} mmHg have low volatilities (Ney, 1990). In general, chemicals with low vapor pressures and high affinity for soils or water are less apt to vaporize.

B.4 HENRY'S LAW CONSTANT

Henry's Law constant incorporates molecular weight, solubility, and vapor pressure to indicate the degree of volatility of a chemical in solution. Chemicals with a Henry's Law constant greater than 1^{-03} atmospheres-cubic meters/mole (atm-m^3/mol) are considered highly volatile, and chemicals with a Henry's Law constant less than 3^{-07} atm-m^3/mol are considered non-volatile. Henry's Law constant is conventionally expressed as a ratio of partial pressures in the vapor to the concentration in the liquid. It is, therefore, a coefficient that reflects the air-water partitioning.

B.5 OCTANOL-WATER PARTITIONING COEFFICIENT

The K_{ow} value is the ratio of the concentration of an organic chemical in octanol divided b the concentration of the chemical in water. The K_{ow} expresses the extent of chemical affinity for octanol versus water. This value gives an indication of how hydrophobic the chemical is and its potential to adsorb to soil or to bioaccumulate in organisms. The grater the K_{ow}, the more likely the chemical will accumulate in soil, sediment, and biota. Chemicals with low K_{ow} values tend to partition mostly to air or water. In general, as K_{ow} increases, bioaccumulation, persistence, and adsorption increase while water solubility, mobility, and biodegradation decrease. Chemicals with log K_{ow} values greater than 3 are expected to adsorb to soil and to bioaccumualte, and chemicals with log K_{ow} values less than 2.7 are not expected to significantly adsorb to soil or to bioaccumulate (Ney, 1990).

B.6 ORGANIC CARBON-WATER PARTITIONING COEFFICIENT

The K_{oc} value is a measure of the propensity for organic compounds to be adsorbed by organic carbon in soil and sediment. A high K_{oc} (>10,000) indicates a chemical is expected to be sorbed tightly to carbon-containing soil and to be less available for migration to water. Chemicals with K_{oc} values between 100 to 10,000 are expected to be moderately sorbed. A low K_{oc} value (<100) indicates a chemical is expected to be weakly sorbed and available for migration (Ney, 1990).

B.7 AIR DIFFUSION COEFFICIENT

The air diffusion coefficient is used to estimate the average rate of migration of a chemical in the air-filled voids of soil. The air diffusion coefficient is directly related to a chemical's molecular weight while the rate of diffusion is primarily dependent on concentration gradient within a soil system. The relationship

between a nonreactive chemical's molecular weight and its air diffusion coefficient is governed by the following equation (Dragun, 1998).

$$D_1/D_2 = (MW_1/MW_2)^{0.5}$$

Where:

D_1 = Air Diffusion Coefficient of Chemical A

D_2 = Air Diffusion Coefficient of Chemical B

MW_1 = Molecular Weight of Chemical A

MW_2 = Molecular Weight of Chemical B

B.8 CHEMICAL DEGRADATION

Chemical degradation through physical or biological processes can be expressed by a chemical's $h_{1/2}$. Assuming first order decay, the ratio of the current chemical concentration (C) to the original chemical concentration (C_o) is expressed as (C/C_o) as is exponentially proportional to time (t), or $C/C_o = e^{-kt}$. The decay constant (k) is related to the $h_{1/2}$ by the equation: $k = 0.693/ h_{1/2}$. Degradation of an organic chemical in the environment is not only dependent on its chemical structure but also on many site-specific factors, such as the presence of microorganisms capable of degrading the chemical and number of these organisms presents (Dragun, 1988).

B.9 SITE-SPECIFIC FACOTRS

Site-specific factors and physical properties of the soil affect groundwater flow patterns and the behavior of chemicals released to the environment. Site-specific factors such as rainfall, temperature, wind, and topography impact groundwater recharge rates, soil moisture content, runoff, volatilization rates, hydraulic gradient, and other environmental conditions affecting contaminant migration potential.

Soil characteristics (including configuration, composition, porosity, permeability, cation exchange capacity, and organic carbon content) will influence rates of percolation, contaminant portioning, and transport. Physical soil properties such as porosity, bulk density, permeability, and organic fraction will influence groundwater flow rates, percolation rates, and chemical adsorption.

Site hydrogeologic characteristics reveal groundwater occurrences and flow patterns, including the potential for contaminants to migrate to and with groundwater and reach surface water.

The amount of biological activity in the soil will help to determine the biodegradation rates of contaminants in the subsurface. Biological activity in soil and water is an additional important

determinant of chemical fate and persistence in the environment. Aerobic and anaerobic microbes (biodegraders) break down organic chemicals into biodegradation products. Several factors affect the rate of biodegradation. Among them are pH, temperature, numbers and types of microbes, available nutrients, moisture, and the concentration and mix of chemicals present (which may serve as the carbon source or substrate).

Chemical environmental persistence is measured in terms of h. It should be noted that reported h are generally for chemical and biological degradation processes only and do not consider transport processes such as volatilization or leaching. In most cases, the actual persistence of a chemical in a given medium is dependent on dilution, biotic, and abiotic removal processes and would, therefore, be less than that indicated by h calculations or advective processes alone.

B.10 PERSISTENCE OF CONSTITUENTS

Organic chemicals are generally removed from the environment by chemical, physical and biological mechanisms that include the following processes:

- Photolysis
- Photooxidation
- Hydrolysis
- Biodegradation

In the subsurface environment, photolysis and photooxidation are not considered to be significant degradation mechanisms. Hydrolysis may occur for some chemicals; however, for chemicals amenable to biodegradion, hydrolysis generally is less important removal mechanisms than is biodegradation. Biological activity in soil and water is an important determinant of chemical fate and persistence in the environment.

B.11 REFERENCES

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APPENDIX C

Screening Standards
(Provided on CD)

- **Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (January 2000)**
- **KDHE Kansas Surface Water Quality Standards, Tables of Numeric Criteria (December 2004)**
- **NOAA SQuiRTs (November 2008)**
- **USEPA MCLs (May 2009)**
- **KDHE RSK Manual – 5th Version (October 2010)**
- **USEPA National Recommended Water Quality Criteria (January 2013)**
- **USEPA RSLs, Summary Tables (Composite Table) (May 2013)**

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (January 2000)

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Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems

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Abstract. Numerical sediment quality guidelines (SQGs) for freshwater ecosystems have previously been developed using a variety of approaches. Each approach has certain advantages and limitations which influence their application in the sediment quality assessment process. In an effort to focus on the agreement among these various published SQGs, consensus-based SQGs were developed for 28 chemicals of concern in freshwater sediments (*i.e.*, metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and pesticides). For each contaminant of concern, two SQGs were developed from the published SQGs, including a threshold effect concentration (TEC) and a probable effect concentration (PEC). The resultant SQGs for each chemical were evaluated for reliability using matching sediment chemistry and toxicity data from field studies conducted throughout the United States. The results of this evaluation indicated that most of the TECs (*i.e.*, 21 of 28) provide an accurate basis for predicting the absence of sediment toxicity. Similarly, most of the PECs (*i.e.*, 16 of 28) provide an accurate basis for predicting sediment toxicity. Mean PEC quotients were calculated to evaluate the combined effects of multiple contaminants in sediment. Results of the evaluation indicate that the incidence of toxicity is highly correlated to the mean PEC quotient (R^2 = 0.98 for 347 samples). It was concluded that the consensus-based SQGs provide a reliable basis for assessing sediment quality conditions in freshwater ecosystems.

Numerical sediment quality guidelines (SQGs; including sediment quality criteria, sediment quality objectives, and sediment quality standards) have been developed by various federal, state, and provincial agencies in North America for both freshwater and marine ecosystems. Such SQGs have been used in numerous applications, including designing monitoring programs, interpreting historical data, evaluating the need for detailed sediment quality assessments, assessing the quality of prospective dredged materials, conducting remedial investigations and ecological risk assessments, and developing sediment quality remediation objectives (Long and MacDonald 1998). Numerical SQGs have also been used by many scientists and managers to identify contaminants of concern in aquatic ecosystems and to rank areas of concern on a regional or national basis (*e.g.*, US EPA 1997a). It is apparent, therefore, that numerical SQGs, when used in combination with other tools, such as sediment toxicity tests, represent a useful approach for assessing the quality of freshwater and marine sediments (MacDonald *et al.* 1992; US EPA 1992, 1996a, 1997a; Adams *et al.* 1992; Ingersoll *et al.* 1996, 1997).

The SQGs that are currently being used in North America have been developed using a variety of approaches. The approaches that have been selected by individual jurisdictions depend on the receptors that are to be considered (*e.g.*, sediment-dwelling organisms, wildlife, or humans), the degree of protection that is to be afforded, the geographic area to which the values are intended to apply (*e.g.*, site-specific, regional, or national), and their intended uses (*e.g.*, screening tools, remediation objectives, identifying toxic and not-toxic samples, bioaccumulation assessment). Guidelines for assessing sediment quality relative to the potential for adverse effects on sediment-dwelling organisms in freshwater systems have been derived using a combination of theoretical and empirical approaches, primarily including the equilibrium partitioning approach (EqPA; Di Toro *et al.* 1991; NYSDEC 1994; US EPA 1997a), screening level concentration approach (SLCA; Persaud *et al.* 1993), effects range approach (ERA; Long and Morgan 1991; Ingersoll *et al.* 1996), effects level approach (ELA; Smith *et al.* 1996; Ingersoll *et al.* 1996), and apparent effects threshold approach (AETA; Cubbage *et al.* 1997). Application of these methods has resulted in the derivation of numerical SQGs for many chemicals of potential concern in freshwater sediments.

Selection of the most appropriate SQGs for specific applications can be a daunting task for sediment assessors. This task is particularly challenging because limited guidance is currently available on the recommended uses of the various SQGs. In addition, the numerical SQGs for any particular substance can differ by several orders of magnitude, depending on the derivation procedure and intended use. The SQG selection process is further complicated due to uncertainties regarding

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the bioavailability of sediment-associated contaminants, the effects of covarying chemicals and chemical mixtures, and the ecological relevance of the guidelines (MacDonald *et al.* 2000). It is not surprising, therefore, that controversies have occurred over the proper use of these sediment quality assessment tools.

This paper represents the third in a series that is intended to address some of the difficulties associated with the assessment of sediment quality conditions using various numerical SQGs. The first paper was focused on resolving the "mixture paradox" that is associated with the application of empirically derived SQGs for individual PAHs. In this case, the paradox was resolved by developing consensus SQGs for ΣPAHs (*i.e.*, total PAHs; Swartz 1999). The second paper was directed at the development and evaluation of consensus-based sediment effect concentrations for total PCBs, which provided a basis for resolving a similar mixture paradox for that group of contaminants using empirically derived SQGs (MacDonald *et al.* 2000). The results of these investigations demonstrated that consensus-based SQGs provide a unifying synthesis of the existing guidelines, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures in sediment (Swartz 1999).

The purpose of this third paper is to further address uncertainties associated with the application of numerical SQGs by providing a unifying synthesis of the published SQGs for freshwater sediments. To this end, the published SQGs for 28 chemical substances were assembled and classified into two categories in accordance with their original narrative intent. These published SQGs were then used to develop two consensus-based SQGs for each contaminant, including a threshold effect concentration (TEC; below which adverse effects are not expected to occur) and a probable effect concentration (PEC; above which adverse effects are expected to occur more often than not). An evaluation of resultant consensus-based SQGs was conducted to provide a basis for determining the ability of these tools to predict the presence, absence, and frequency of sediment toxicity in field-collected sediments from various locations across the United States.

Materials and Methods

Derivation of the Consensus-Based SQGs

A stepwise approach was used to develop the consensus-based SQGs for common contaminants of concern in freshwater sediments. As a first step, the published SQGs that have been derived by various investigators for assessing the quality of freshwater sediments were collated. Next, the SQGs obtained from all sources were evaluated to determine their applicability to this study. To facilitate this evaluation, the supporting documentation for each of the SQGs was reviewed. The collated SQGs were further considered for use in this study if: (1) the methods that were used to derive the SQGs were readily apparent; (2) the SQGs were based on empirical data that related contaminant concentrations to harmful effects on sediment-dwelling organisms or were intended to be predictive of effects on sediment-dwelling organisms (*i.e.*, not simply an indicator of background contamination); and (3) the SQGs had been derived on a *de novo* basis (*i.e.*, not simply adopted from another jurisdiction or source). It was not the intent of this paper to collate bioaccumulation-based SQGs.

The SQGs that were expressed on an organic carbon–normalized basis were converted to dry weight–normalized values at 1% organic carbon (MacDonald *et al.* 1994, 1996; US EPA 1997a). The dry weight–normalized SQGs were utilized because the results of previous studies have shown that they predicted sediment toxicity as well or better than organic carbon–normalized SQGs in field-collected sediments (Barrick *et al.* 1988; Long *et al.* 1995; Ingersoll *et al.* 1996; US EPA 1996a; MacDonald 1997).

The effects-based SQGs that met the selection criteria were then grouped to facilitate the derivation of consensus-based SQGs (Swartz 1999). Specifically, the previously published SQGs for the protection of sediment-dwelling organisms in freshwater ecosystems were grouped into two categories according to their original narrative intent, including TECs and PECs. The TECs were intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms were not expected. TECs include threshold effect levels (TELs; Smith *et al.* 1996; US EPA 1996a), effect range low values (ERLs; Long and Morgan 1991), lowest effect levels (LELs; Persaud *et al.* 1993), minimal effect thresholds (METs; EC and MENVIQ 1992), and sediment quality advisory levels (SQALs; US EPA 1997a). The PECs were intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms were expected to occur frequently (MacDonald *et al.* 1996; Swartz 1999). PECs include probable effect levels (PELs; Smith *et al.* 1996; US EPA 1996a), effect range median values (ERMs; Long and Morgan 1991); severe effect levels (SELs; Persaud *et al.* 1993), and toxic effect thresholds (TETs; EC and MENVIQ 1992; Table 1).

Following classification of the published SQGs, consensus-based TECs were calculated by determining the geometric mean of the SQGs that were included in this category (Table 2). Likewise, consensus-based PECs were calculated by determining the geometric mean of the PEC-type values (Table 3). The geometric mean, rather than the arithmetic mean or median, was calculated because it provides an estimate of central tendency that is not unduly affected by extreme values and because the distributions of the SQGs were not known (MacDonald *et al.* 2000). Consensus-based TECs or PECs were calculated only if three of more published SQGs were available for a chemical substance or group of substances.

Evaluation of the SQGs

The consensus-based SQGs were critically evaluated to determine if they would provide effective tools for assessing sediment quality conditions in freshwater ecosystems. Specifically, the reliability of the individual or combined consensus-based TECs and PECs for assessing sediment quality conditions was evaluated by determining their predictive ability. In this study, predictive ability is defined as the ability of the various SQGs to correctly classify field-collected sediments as toxic or not toxic, based on the measured concentrations of chemical contaminants. The predictive ability of the SQGs was evaluated using a three-step process.

In the first step of the SQG evaluation process, matching sediment chemistry and biological effects data were compiled for various freshwater locations in the United States. Because the data sets were generated for a wide variety of purposes, each study was evaluated to assure the quality of the data used for evaluating the predictive ability of the SQGs (Long *et al.* 1998; Ingersoll and MacDonald 1999). As a result of this evaluation, data from the following freshwater locations were identified for use in this paper: Grand Calumet River and Indiana Harbor Canal, IN (Hoke *et al.* 1993; Giesy *et al.* 1993; Burton 1994; Dorkin 1994); Indiana Harbor, IN (US EPA 1993a, 1996a, 1996b); Buffalo River, NY (US EPA 1993c, 1996a); Saginaw River, MI (US EPA 1993b, 1996a); Clark Fork River, MT (USFWS 1993); Milltown Reservoir, MT (USFWS 1993); Lower Columbia River, WA (Johnson and Norton 1988); Lower Fox River and Green Bay, WI (Call *et al.* 1991); Potomac River, DC (Schlekat *et al.* 1994; Wade *et al.* 1994; Velinsky *et al.* 1994); Trinity River, TX (Dickson *et al.* 1989; US EPA 1996a); Upper Mississippi River, MN to MO (US EPA 1996a, 1997b);

Table 1. Descriptions of the published freshwater SQGs that have been developed using various approaches

Type of SQG	Acronym	Approach	Description	Reference
Threshold effect concentration SQGs				
Lowest effect level	LEL	SLCA	Sediments are considered to be clean to marginally polluted. No effects on the majority of sediment-dwelling organisms are expected below this concentration.	Persaud *et al.* (1993)
Threshold effect level	TEL	WEA	Represents the concentration below which adverse effects are expected to occur only rarely.	Smith *et al.* (1996)
Effect range—low	ERL	WEA	Represents the chemical concentration below which adverse effects would be rarely observed.	Long and Morgan (1991)
Threshold effect level for *Hyalella azteca* in 28-day tests	TEL-HA28	WEA	Represents the concentration below which adverse effects on survival or growth of the amphipod *Hyalella azteca* are expected to occur only rarely (in 28-day tests).	US EPA (1996a); Ingersoll *et al.* (1996)
Minimal effect threshold	MET	SLCA	Sediments are considered to be clean to marginally polluted. No effects on the majority of sediment-dwelling organisms are expected below this concentration.	EC and MENVIQ (1992)
Chronic equilibrium partitioning threshold	SQAL	EqPA	Represents the concentration in sediments that is predicted to be associated with concentrations in the interstitial water below a chronic water quality criterion. Adverse effects on sediment-dwelling organisms are predicted to occur only rarely below this concentration.	Bolton *et al.* (1985); Zarba (1992); US EPA (1997a)
Probable effect concentration SQGs				
Severe effect level	SEL	SLCA	Sediments are considered to be heavily polluted. Adverse effects on the majority of sediment-dwelling organisms are expected when this concentration is exceeded.	Persaud *et al.* (1993)
Probable effect level	PEL	WEA	Represents the concentration above which adverse effects are expected to occur frequently.	Smith *et al.* (1996)
Effect range—median	ERM	WEA	Represents the chemical concentration above which adverse effects would frequently occur.	Long and Morgan (1991)
Probable effect level for *Hyalella azteca* in 28-day tests	PEL-HA28	WEA	Represents the concentration above which adverse effects on survival or growth of the amphipod *Hyalella azteca* are expected to occur frequently (in 28-day tests).	US EPA (1996a); Ingersoll *et al.* (1996)
Toxic effect threshold	TET	SLCA	Sediments are considered to be heavily polluted. Adverse effects on sediment-dwelling organisms are expected when this concentration is exceeded.	EC and MENVIQ (1992)

and Waukegan Harbor, IL (US EPA 1996a; Kemble *et al.* 1999). These studies provided 17 data sets (347 sediment samples) with which to evaluate the predictive ability of the SQGs. These studies also represented a broad range in both sediment toxicity and contamination; roughly 50% of these samples were found to be toxic based on the results of the various toxicity tests (the raw data from these studies are summarized in Ingersoll and MacDonald 1999).

In the second step of the evaluation, the measured concentration of each substance in each sediment sample was compared to the corresponding SQG for that substance. Sediment samples were predicted to be not toxic if the measured concentrations of a chemical substance were lower than the corresponding TEC. Similarly, samples were predicted to be toxic if the corresponding PECs were exceeded in field-collected sediments. Samples with contaminant concentrations between the TEC and PEC were neither predicted to be toxic nor nontoxic (*i.e.*, the individual SQGs are not intended to provide guidance within this range of concentrations). The comparisons of measured concentrations to the SQGs were conducted for each of the 28 chemicals of concern for which SQGs were developed.

In the third step of the evaluation, the accuracy of each prediction

Table 2. Sediment quality guidelines for metals in freshwater ecosystems that reflect TECs (*i.e.*, below which harmful effects are unlikely to be observed)

	Threshold Effect Concentrations						
Substance	TEL	LEL	MET	ERL	TEL-HA28	SQAL	Consensus-Based TEC
Metals (in mg/kg DW)							
Arsenic	5.9	6	7	33	11	NG	9.79
Cadmium	0.596	0.6	0.9	5	0.58	NG	0.99
Chromium	37.3	26	55	80	36	NG	43.4
Copper	35.7	16	28	70	28	NG	31.6
Lead	35	31	42	35	37	NG	35.8
Mercury	0.174	0.2	0.2	0.15	NG	NG	0.18
Nickel	18	16	35	30	20	NG	22.7
Zinc	123	120	150	120	98	NG	121
Polycyclic aromatic hydrocarbons (in µg/kg DW)							
Anthracene	NG	220	NG	85	10	NG	57.2
Fluorene	NG	190	NG	35	10	540	77.4
Naphthalene	NG	NG	400	340	15	470	176
Phenanthrene	41.9	560	400	225	19	1,800	204
Benz[a]anthracene	31.7	320	400	230	16	NG	108
Benzo(a)pyrene	31.9	370	500	400	32	NG	150
Chrysene	57.1	340	600	400	27	NG	166
Dibenz[a,h]anthracene	NG	60	NG	60	10	NG	33.0
Fluoranthene	111	750	600	600	31	6,200	423
Pyrene	53	490	700	350	44	NG	195
Total PAHs	NG	4,000	NG	4,000	260	NG	1,610
Polychlorinated biphenyls (in µg/kg DW)							
Total PCBs	34.1	70	200	50	32	NG	59.8
Organochlorine pesticides (in µg/kg DW)							
Chlordane	4.5	7	7	0.5	NG	NG	3.24
Dieldrin	2.85	2	2	0.02	NG	110	1.90
Sum DDD	3.54	8	10	2	NG	NG	4.88
Sum DDE	1.42	5	7	2	NG	NG	3.16
Sum DDT	NG	8	9	1	NG	NG	4.16
Total DDTs	7	7	NG	3	NG	NG	5.28
Endrin	2.67	3	8	0.02	NG	42	2.22
Heptachlor epoxide	0.6	5	5	NG	NG	NG	2.47
Lindane (gamma-BHC)	0.94	3	3	NG	NG	3.7	2.37

TEL = Threshold effect level; dry weight (Smith *et al.* 1996)
LEL = Lowest effect level, dry weight (Persaud *et al.* 1993)
MET = Minimal effect threshold; dry weight (EC and MENVIQ 1992)
ERL = Effect range low; dry weight (Long and Morgan 1991)
TEL-HA28 = Threshold effect level for Hyalella azteca; 28 day test; dry weight (US EPA 1996a)
SQAL = Sediment quality advisory levels; dry weight at 1% OC (US EPA 1997a)
NG = No guideline

was evaluated by determining if the sediment sample actually was toxic to one or more aquatic organisms, as indicated by the results of various sediment toxicity tests (Ingersoll and MacDonald 1999). The following responses of aquatic organisms to contaminant challenges (*i.e.*, toxicity test endpoints) were used as indicators of toxicity in this assessment (*i.e.*, sediment samples were designated as toxic if one or more of the following endpoints were significantly different from the responses observed in reference or control sediments), including amphipod (*Hyalella azteca*) survival, growth, or reproduction; mayfly (*Hexagenia limbata*) survival or growth; midge (*Chironomus tentans* or *Chironomus riparius*) survival or growth; midge deformities; oligochaete (*Lumbriculus variegatus*) survival; daphnid (*Ceriodaphnia dubia*) survival; and bacterial (*Photobacterium phosphoreum*) luminescence (*i.e.*, Microtox). In contrast, sediment samples were designated as nontoxic if they did not cause a significant response in at least one of these test endpoints. In this study, predictive ability was calculated as the ratio of the number of samples that were correctly classified as toxic or nontoxic to the total number of samples that were predicted to be toxic or nontoxic using the various SQGs (predictive ability was expressed as a percentage).

The criteria for evaluating the reliability of the consensus-based PECs were adapted from Long *et al.* (1998). These criteria are intended to reflect the narrative intent of each type of SQG (*i.e.*, sediment toxicity should be observed only rarely below the TEC and should be frequently observed above the PEC). Specifically, the individual TECs were considered to provide a reliable basis for assessing the quality of freshwater sediments if more than 75% of the sediment samples were correctly predicted to be not toxic. Similarly, the individual PEC for each substance was considered to be reliable if greater than 75% of the sediment samples were correctly predicted to toxic using the PEC. Therefore, the target levels of both false positives (*i.e.*, samples incorrectly classified as toxic) and false negatives (*i.e.*, samples incorrectly classified as not toxic) was 25% using the TEC and PEC. To assure that the results of the predictive ability evaluation were

Table 3. Sediment quality guidelines for metals in freshwater ecosystems that reflect PECs (*i.e.*, above which harmful effects are likely to be observed)

	Probable Effect Concentrations					
Substance	PEL	SEL	TET	ERM	PEL-HA28	Consensus-Based PEC
Metals (in mg/kg DW)						
Arsenic	17	33	17	85	48	33.0
Cadmium	3.53	10	3	9	3.2	4.98
Chromium	90	110	100	145	120	111
Copper	197	110	86	390	100	149
Lead	91.3	250	170	110	82	128
Mercury	0.486	2	1	1.3	NG	1.06
Nickel	36	75	61	50	33	48.6
Zinc	315	820	540	270	540	459
Polycyclic aromatic hydrocarbons (in μg/kg DW)						
Anthracene	NG	3,700	NG	960	170	845
Fluorene	NG	1,600	NG	640	150	536
Naphthalene	NG	NG	600	2,100	140	561
Phenanthrene	515	9,500	800	1,380	410	1,170
Benz[a]anthracene	385	14,800	500	1,600	280	1,050
Benzo(a)pyrene	782	14,400	700	2,500	320	1,450
Chrysene	862	4,600	800	2,800	410	1,290
Fluoranthene	2,355	10,200	2,000	3,600	320	2,230
Pyrene	875	8,500	1,000	2,200	490	1,520
Total PAHs	NG	100,000	NG	35,000	3,400	22,800
Polychlorinated biphenyls (in μg/kg DW)						
Total PCBs	277	5,300	1,000	400	240	676
Organochlorine pesticides (in μg/kg DW)						
Chlordane	8.9	60	30	6	NG	17.6
Dieldrin	6.67	910	300	8	NG	61.8
Sum DDD	8.51	60	60	20	NG	28.0
Sum DDE	6.75	190	50	15	NG	31.3
Sum DDT	NG	710	50	7	NG	62.9
Total DDTs	4,450	120	NG	350	NG	572
Endrin	62.4	1,300	500	45	NG	207
Heptachlor Epoxide	2.74	50	30	NG	NG	16.0
Lindane (gamma-BHC)	1.38	10	9	NG	NG	4.99

PEL = Probable effect level; dry weight (Smith *et al.* 1996)
SEL = Severe effect level, dry weight (Persaud *et al.* 1993)
TET = Toxic effect threshold; dry weight (EC and MENVIQ 1992)
ERM = Effect range median; dry weight (Long and Morgan 1991)
PEL-HA28 = Probable effect level for *Hyalella azteca*; 28-day test; dry weight (US EPA 1996a)
NG = No guideline

not unduly influenced by the number of sediment samples available to conduct the evaluation of predictive ability, the various SQGs were considered to be reliable only if a minimum of 20 samples were included in the predictive ability evaluation (CCME 1995).

The initial evaluation of predictive ability was focused on determining the ability of each SQG when applied alone to classify samples correctly as toxic or nontoxic. Because field-collected sediments typically contain complex mixtures of contaminants, the predictability of these sediment quality assessment tools is likely to increase when the SQGs are used together to classify these sediments. For this reason, a second evaluation of the predictive ability of the SQGs was conducted to determine the incidence of effects above and below various mean PEC quotients (*i.e.*, 0.1, 0.5, 1.0, and 1.5). In this evaluation, mean PEC quotients were calculated using the methods of Long *et al.* (1998; *i.e.*, for each sediment sample, the average of the ratios of the concentration of each contaminant to its corresponding PEC was calculated for each sample), with only the PECs that were found to be reliable used in these calculations. The PEC for total PAHs (*i.e.*, instead of the PECs for the individual PAHs) was used in the calculation to avoid double counting of the PAH concentration data.

Results and Discussion

Derivation of Consensus-Based SQGs

A variety of approaches have been developed to support the derivation of numerical SQGs for the protection of sediment-dwelling organisms in the United States and Canada. MacDonald (1994), Ingersoll and MacDonald (1999), and MacDonald *et al.* (2000) provided reviews of the various approaches to SQG development, including descriptions of the derivation methods, the advantages and limitations of the resultant SQGs, and their recommended uses. This information,

along with the supporting documentation that was obtained with the published SQGs, was used to evaluate the relevance of the various SQGs in this investigation.

Subsequently, the narrative descriptions of the various SQGs were used to classify the SQGs into appropriate categories (*i.e.*, TECs or PECs; Table 1). The results of this classification process indicated that six sets of SQGs were appropriate for deriving consensus-based TECs for the contaminants of concern in freshwater sediments, including: (1) TELs (Smith *et al.* 1996); (2) LELs (Persaud *et al.* 1993); (3) METs (EC and MENVIQ 1992); (4) ERLs (Long and Morgan 1991); (5) TELs for *H. azteca* in 28-day toxicity tests (US EPA 1996a; Ingersoll *et al.* 1996); and (6) SQALs (US EPA 1997a).

Several other SQGs were also considered for deriving consensus TECs, but they were not included for the following reasons. First, none of the SQGs that have been developed using data on the effects on sediment-associated contaminants in marine sediments only were used to derive TECs. However, the ERLs that were derived using both freshwater and marine data were included (*i.e.*, Long and Morgan 1991). Second, the ERLs that were developed by the US EPA (1996a) were not utilized because they were developed from the same data that were used to derive the TELs (*i.e.*, from several areas of concern in the Great Lakes). In addition, simultaneously extracted metals–acid volatile sulfide (SEM-AVS)–based SQGs were not used because they could not be applied without simultaneous measurements of SEM and AVS concentrations (Di Toro *et al.* 1990). None of the SQGs that were derived using the sediment background approach were used because they were not effects-based. Finally, no bioaccumulation-based SQGs were used to calculate the consensus-based TECs. The published SQGs that corresponded to TECs for metals, PAHs, PCBs, and organochlorine pesticides are presented in Table 2.

Based on the results of the initial evaluation, five sets of SQGs were determined to be appropriate for calculating consensus-based PECs for the contaminants of concern in freshwater sediments, including: (1) probable effect levels (PELs; Smith *et al.* 1996); (2) severe effect levels (SELs; (Persaud *et al.* 1993); (3) toxic effect thresholds (TETs; EC and MENVIQ 1992); (4) effect range median values (ERMs; Long and Morgan 1991); and (5) PELs for *H. azteca* in 28-day toxicity tests (US EPA 1996a; Ingersoll *et al.* 1996).

While several other SQGs were considered for deriving the consensus-based PECs, they were not included for the following reasons. To maximize the applicability of the resultant guidelines to freshwater systems, none of the SQGs that were developed for assessing the quality of marine sediments were used to derive the freshwater PECs. As was the case for the TECs, the ERMs that were derived using both freshwater and marine data (*i.e.*, Long and Morgan 1991) were included, however. The ERMs that were derived using data from various areas of concern in the Great Lakes (*i.e.*, US EPA 1996a) were not included to avoid duplicate representation of these data in the consensus-based PECs. In addition, none of the SEM-AVS–based SQGs were not used in this evaluation. Furthermore, none of the AET or related values (*e.g.*, NECs from Ingersoll *et al.* 1996; PAETs from Cubbage *et al.* 1997) were used because they were not considered to represent toxicity thresholds (rather, they represent contaminant concentrations above which harmful biological effects always occur). The published SQGs that corresponded to PECs for metals, PAHs, PCBs, and organochlorine pesticides are presented in Table 3.

For each substance, consensus-based TECs or PECs were derived if three or more acceptable SQGs were available. The consensus-based TECs or PECs were determined by calculating the geometric mean of the published SQGs and rounding to three significant digits. Application of these procedures facilitated the derivation of numerical SQGs for a total of 28 chemical substances, including 8 trace metals, 10 individual PAHs and PAH classes, total PCBs, and 9 organochlorine pesticides and degradation products. The consensus-based SQGs that were derived for the contaminants of concern in freshwater ecosystems are presented in Tables 2 and 3.

Predictive Ability of the Consensus-Based SQGs

Matching sediment chemistry and toxicity data from various locations in the United States were used to evaluate the predictive ability of the consensus-based SQGs in freshwater sediments. Within this independent data set, the overall incidence of toxicity was about 50% (*i.e.*, 172 of the 347 samples evaluated in these studies were identified as being toxic to one or more sediment-dwelling organisms). Therefore, 50% of the samples with contaminant concentrations below the TEC, between the TEC and the PEC, and above PECs would be predicted to be toxic if sediment toxicity was unrelated to sediment chemistry (*i.e.*, based on random chance alone).

The consensus-based TECs are intended to identify the concentrations of sediment-associated contaminants below which adverse effects on sediment-dwelling organisms are not expected to occur. Sufficient data were available to evaluate the predictive ability of all 28 consensus-based TECs. Based on the results of this assessment, the incidence of sediment toxicity was generally low at contaminant concentrations below the TECs (Table 4). Except for mercury, the predictive ability of the TECs for the trace metals ranged from 72% for chromium to 82% for copper, lead, and zinc. The predictive ability of the TECs for PAHs was similar to that for the trace metals, ranging from 71% to 83%. Among the organochlorine pesticides, the predictive ability of the TECs was highest for chlordane (85%) and lowest for endrin (71%). At 89%, the predictive ability of the TEC for total PCBs was the highest observed among the 28 substances for which SQGs were derived. Overall, the TECs for 21 substances, including four trace metals, eight individual PAHs, total PAHs, total PCBs, and seven organochlorine pesticides, were found to predict accurately the absence of toxicity in freshwater sediments (*i.e.*, predictive ability $\geq$75%; $\geq$20 samples below the TEC; Table 4). Therefore, the consensus-based TECs generally provide an accurate basis for predicting the absence of toxicity to sediment-dwelling organisms in freshwater sediments.

In contrast to the TECs, the consensus-based PECs are intended to define the concentrations of sediment-associated contaminants above which adverse effects on sediment-dwelling organisms are likely to be observed. Sufficient data were available to evaluate the PECs for 17 chemical substances, including 7 trace metals, 6 individual PAHs, total PAHs, total PCBs, and 2 organochlorine pesticides (*i.e.*, $\geq$20 samples predicted to be toxic). The results of the evaluation of predictive ability demonstrate that the PECs for 16 of the 17 substances meet the criteria for predictive ability that

Table 4. Predictive ability of the consensus-based TECs in freshwater sediments

Substance	Number of Samples Evaluated	Number of Samples Predicted to Be Not Toxic	Number of Samples Observed to Be Not Toxic	Percentage of Samples Correctly Predicted to Be Not Toxic
Metals				
Arsenic	150	58	43	74.1
Cadmium	347	102	82	80.4
Chromium	347	132	95	72.0
Copper	347	158	130	82.3
Lead	347	152	124	81.6
Mercury	79	35	12	34.3
Nickel	347	184	133	72.3
Zinc	347	163	133	81.6
Polycyclic aromatic hydrocarbons				
Anthracene	129	75	62	82.7
Fluorene	129	93	66	71.0
Naphthalene	139	85	64	75.3
Phenanthrene	139	79	65	82.3
Benz(a)anthracene	139	76	63	82.9
Benzo(a)pyrene	139	81	66	81.5
Chrysene	139	80	64	80.0
Dibenz(a,h)anthracene	98	77	56	72.7
Fluoranthene	139	96	72	75.0
Pyrene	139	78	62	79.5
Total PAHs	167	81	66	81.5
Polychlorinated biphenyls				
Total PCBs	120	27	24	88.9
Organochlorine pesticides				
Chlordane	193	101	86	85.1
Dieldrin	180	109	91	83.5
Sum DDD	168	101	81	80.2
Sum DDE	180	105	86	81.9
Sum DDT	96	100	77	77.0
Total DDT	110	92	76	82.6
Endrin	170	126	89	70.6
Heptachlor epoxide	138	90	74	82.2
Lindane	180	121	87	71.9

were established in this study (Table 5). Among the seven individual trace metals, the predictive ability of the PECs ranged from 77% for arsenic to 94% for cadmium. The PECs for six individual PAHs and total PAHs were also demonstrated to be reliable, with predictive abilities ranging from 92% to 100%. The predictive ability of the PEC for total PCBs was 82%. While the PEC for Sum DDE was also found to be an accurate predictor of sediment toxicity (*i.e.*, predictive ability of 97%), the predictive ability of the PEC for chlordane was somewhat lower (*i.e.*, 73%). Therefore, the consensus-based PECs for arsenic, cadmium, chromium, copper, lead, nickel, zinc, naphthalene, phenanthrene, benz[a]anthracene, benzo(a)pyrene, chrysene, pyrene, total PAHs, total PCBs, and sum DDE provide an accurate basis for predicting toxicity in freshwater sediments from numerous locations in North America (*i.e.*, predictive ability of $\geq$75%; Table 5). Insufficient data were available (*i.e.*, fewer than 20 samples predicted to be toxic) to evaluate the PECs for mercury, anthracene, fluorene, fluoranthene, dieldrin, sum DDD, sum DDT, total DDT, endrin, heptachlor epoxide, and lindane (Table 5).

The two types of SQGs define three ranges of concentrations for each chemical substance. It is possible to assess the degree of concordance that exists between chemical concentrations and the incidence of sediment toxicity (Table 6; MacDonald *et al.* 1996) by determining the ratio of toxic samples to the total number of samples within each of these three ranges of concentrations for each substance. The results of this evaluation demonstrate that, for most chemical substances (*i.e.*, 20 of 28), there is a consistent and marked increase in the incidence of toxicity to sediment-dwelling organisms with increasing chemical concentrations. For certain substances, such as naphthalene, mercury, chlordane, dieldrin, and sum DDD, a lower PEC may have produced greater concordance between sediment chemistry and the incidence of effects. Insufficient data were available to evaluate the degree of concordance for several substances, such as endrin, heptachlor epoxide, and lindane. The positive correlation between contaminant concentrations and sediment toxicity that was observed increases the degree of confidence that can be placed in the SQGs for most of the substances.

While the SQGs for the individual chemical substances provide reliable tools for assessing sediment quality conditions, predictive ability should be enhanced when used together in assessments of sediment quality. In addition, it would be helpful to consider the magnitude of the exceedances of the SQGs in such assessments. Long *et al.* (1998) developed a procedure for evaluating the biological significance of contaminant mixtures through the application of mean PEC quotients. A three-

Table 5. Predictive ability of the consensus-based PECs in freshwater sediments

Substance	Number of Samples Evaluated	Number of Samples Predicted to Be Toxic	Number of Samples Observed to Be Toxic	Percentage of Samples Correctly Predicted to Be Toxic
Metals				
Arsenic	150	26	20	76.9
Cadmium	347	126	118	93.7
Chromium	347	109	100	91.7
Copper	347	110	101	91.8
Lead	347	125	112	89.6
Mercury	79	4	4	100
Nickel	347	96	87	90.6
Zinc	347	120	108	90.0
Polycyclic aromatic hydrocarbons				
Anthracene	129	13	13	100
Fluorene	129	13	13	100
Naphthalene	139	26	24	92.3
Phenanthrene	139	25	25	100
Benz(a)anthracene	139	20	20	100
Benzo(a)pyrene	139	24	24	100
Chrysene	139	24	23	95.8
Fluoranthene	139	15	15	100
Pyrene	139	28	27	96.4
Total PAHs	167	20	20	100
Polychlorinated biphenyls				
Total PCBs	120	51	42	82.3
Organochlorine pesticides				
Chlordane	193	37	27	73.0
Dieldrin	180	10	10	100
Sum DDD	168	6	5	83.3
Sum DDE	180	30	29	96.7
Sum DDT	96	12	11	91.7
Total DDT	110	10	10	100
Endrin	170	0	0	NA
Heptachlor epoxide	138	8	3	37.5
Lindane	180	17	14	82.4

NA = Not applicable

step process is used in the present study to calculate mean PEC quotients. In the first step, the concentration of each substance in each sediment sample is divided by its respective consensus-based PEC. PEC quotients are calculated only for those substances for which reliable PECs were available. Subsequently, the sum of the PEC quotients was calculated for each sediment sample by adding the PEC quotients that were determined for each substance; however, only the PECs that were demonstrated to be reliable were used in the calculation. The summed PEC quotients were then normalized to the number of PEC quotients that are calculated for each sediment sample (*i.e.*, to calculate the mean PEC quotient for each sample; Canfield *et al.* 1998; Long *et al.* 1998; Kemble *et al.* 1999). This normalization step is conducted to provide comparable indices of contamination among samples for which different numbers of chemical substances were analyzed.

The predictive ability of the PEC quotients, as calculated using the consensus-based SQGs, was also evaluated using data that were assembled to support the predictive ability assessment for the individual PECs. In this evaluation, sediment samples were predicted to be not toxic if mean PEC quotients were <0.1 or <0.5. In contrast, sediment samples were predicted to be toxic when mean PEC quotients exceeded 0.5, 1.0, or 1.5. The results of this evaluation indicated that the consensus-based SQGs, when used, together provide an accurate basis for predicting the absence of sediment toxicity (Table 7; Figure 1). Sixty-one sediment samples had mean PEC quotients of <0.1; six of these samples were toxic to sediment-dwelling organisms (predictive ability = 90%). Of the 174 samples with mean PEC quotients of < 0.5, only 30 were found to be toxic to sediment-dwelling organisms (predictive ability = 83%; Table 7).

The consensus-based SQGs also provided an accurate basis for predicting sediment toxicity in sediments that contained mixtures of contaminants. Of the 173 sediment samples with mean PEC quotients of > 0.5 (calculated using the PECs for seven trace metals, the PEC for total PAHs [rather than the PECs for individual PAHs], the PEC for PCBs, and the PEC for sum DDE), 147 (85%) were toxic to sediment-dwelling organisms (Table 7; Figure 1). Similarly, 92% of the sediment samples (132 of 143) with mean PEC quotients of > 1.0 were toxic to one or more species of aquatic organisms. Likewise, 94% of the sediment samples (118 of 125) with mean PEC quotients of greater than 1.5 were found to be toxic, based on the results of various freshwater toxicity tests. Therefore, it is apparent that a mean PEC quotient of 0.5 represents a useful

Table 6. Incidence of toxicity within ranges of contaminant concentrations defined by the SQGs

Substance	Number of Samples Evaluated	Incidence of Toxicity (%, number of samples in parentheses)		
		≤TEC	TEC-PEC	> PEC
Metals				
Arsenic	150	25.9% (15 of 58)	57.6% (38 of 66)	76.9% (20 of 26)
Cadmium	347	19.6% (20 of 102)	44.6% (29 of 65)	93.7% (118 of 126)
Chromium	347	28% (37 of 132)	64.4% (38 of 59)	91.7% (100 of 109)
Copper	347	17.7% (28 of 158)	64.0% (48 of 75)	91.8% (101 of 110)
Lead	347	18.4% (28 of 152)	53.6% (37 of 69)	89.6% (112 of 125)
Mercury	79	65.7% (23 of 35)	70.0% (28 of 40)	100% (4 of 4)
Nickel	347	27.7% (51 of 184)	62.7% (32 of 51)	90.6% (87 of 96)
Zinc	347	18.4% (30 of 163)	60.9% (39 of 64)	90.0% (108 of 120)
Polycyclic aromatic hydrocarbons				
Anthracene	129	17.3% (13 of 75)	92.9% (26 of 28)	100% (13 of 13)
Fluorene	129	29% (27 of 93)	85.7% (12 of 14)	100% (13 of 13)
Naphthalene	139	24.7% (21 of 85)	94.1% (16 of 17)	92.3% (24 of 26)
Phenanthrene	139	17.7% (14 of 79)	88.2% (30 of 34)	100% (25 of 25)
Benz(a)anthracene	139	17.1% (13 of 76)	70% (14 of 20)	100% (20 of 20)
Benzo(a)pyrene	139	18.5% (15 of 81)	75.7% (28 of 37)	100% (24 of 24)
Chrysene	139	20% (16 of 80)	68.1% (32 of 47)	95.8% (23 of 24)
Fluoranthene	139	25% (24 of 96)	82.5% (33 of 40)	100% (15 of 15)
Pyrene	139	20.5% (16 of 78)	63.0% (29 of 46)	96.4% (27 of 28)
Total PAHs	167	18.5% (15 of 81)	65.1% (43 of 66)	100% (20 of 20)
Polychlorinated biphenyls				
Total PCBs	120	11.1% (3 of 27)	31.0% (9 of 29)	82.3% (42 of 51)
Organochlorine pesticides				
Chlordane	193	14.9% (15 of 101)	75.0% (15 of 20)	73.0% (27 of 37)
Dieldrin	180	16.5% (18 of 109)	95.2% (20 of 21)	100% (10 of 10)
Sum DDD	168	19.8% (20 of 101)	33.3% (1 of 3)	83.3% (5 of 6)
Sum DDE	180	18.1% (19 of 105)	33.3% (1 of 3)	96.7% (29 of 30)
Sum DDT	96	23% (23 of 100)	0.0% (0 of 1)	91.7% (11 of 12)
Total DDT	110	17.4% (16 of 92)	100% (23 of 23)	100% (10 of 10)
Endrin	170	29.4% (37 of 126)	40.0% (4 of 10)	NA% (0 of 0)
Heptachlor epoxide	138	17.8% (16 of 90)	85.0% (17 of 20)	37.5% (3 of 8)
Lindane	180	28.1% (34 of 121)	65.9% (29 of 44)	82.4% (14 of 17)

Table 7. Predictive ability of mean PEC quotients in freshwater sediments

Mean PEC Quotient	Mean PEC Quotients Calculated with Total PAHs Predictive Ability (%)	Mean PEC Quotients Calculated with Individual PAH Predictive Abilities (%)
<0.1	90.2% (61)	90.2% (61)
<0.5	82.8% (174)	82.9% (175)
>0.5	85% (173)	85.4% (172)
>1.0	93.3% (143)	93.4% (143)
>1.5	94.4% (125)	95% (121)

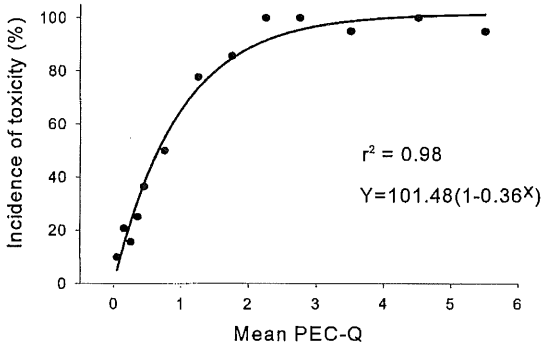

Fig. 1. Relationship between mean PEC quotient and incidence of toxicity in freshwater sediments

threshold that can be used to accurately classify sediment samples as both toxic and not toxic. The results of this evaluation were not substantially different when the PECs for the individuals PAHs (*i.e.*, instead of the PEC for total PAHs) were used to calculate the mean PEC quotients (Table 7). Kemble *et al.* (1999) reported similar results when the mean PEC quotients were evaluated using the results of only 28-day toxicity tests with *H. azteca* (n = 149, 32% of the samples were toxic).

To examine further the relationship between the degree of chemical contamination and probability of observing toxicity in freshwater sediments, the incidence of toxicity within various ranges of mean PEC quotients was calculated (*e.g.*, < 0.1, 0.1–0.2, 0.2–0.3). Next, these data were plotted against the midpoint of each range of mean PEC quotients (Figure 1). Subsequent curve-fitting indicated that the mean PEC-quotient is highly correlated with incidence of toxicity ($r^2 = 0.98$), with the relationship being an exponential function. The resultant

equation can be used to estimate the probability of observing sediment toxicity at any mean PEC quotient.

Although it is important to be able to predict accurately the presence and absence of toxicity in field-collected sediments, it is also helpful to be able to identify the factors that are causing or substantially contributing to sediment toxicity. Such information enables environmental managers to focus limited resources on the highest-priority sediment quality issues and concerns. In this context, it has been suggested that the results of spiked sediment toxicity tests provide a basis for identifying the concentrations of sediment-associated contaminants that cause sediment toxicity (Swartz *et al.* 1988; Ingersoll *et al.* 1997). Unfortunately, there is limited relevant data available that assesses effects of spiked sediment in freshwater systems. For example, the available data from spiked sediment toxicity tests is limited to just a few of the chemical substances for which reliable PECs are available, primarily copper and fluoranthene. Additionally, differences in spiking procedures, equilibration time, and lighting conditions during exposures confound the interpretation of the results of sediment spiking studies, especially for PAHs (ASTM 1999). Moreover, many sediment spiking studies were conducted to evaluate bioaccumulation using relatively insensitive test organisms (*e.g., Diporeia* and *Lumbriculus*) or in sediments containing mixtures of chemical substances (Landrum *et al.* 1989, 1991).

In spite of the limitations associated with the available dose-response data, the consensus-based PECs for copper and fluoranthene were compared to the results of spiked sediment toxicity tests. Suedel (1995) conducted a series of sediment spiking studies with copper and reported 48-h to 14-day LC_{50} for four freshwater species, including the waterfleas *Ceriodaphnia dubia* (32–129 mg/kg DW) and *Daphnia magna* (37–170 mg/kg DW), the amphipod *H. azteca* (247–424 mg/kg DW), and the midge *C. tentans* (1,026–4,522 mg/kg DW). An earlier study reported 10-day LC_{50}s of copper for *H. azteca* (1,078 mg/kg) and *C. tentans* (857 mg/kg), with somewhat higher effect concentrations observed in different sediment types (Cairns *et al.* 1984). The PEC for copper (149 mg/kg DW) is higher than or comparable to (*i.e.*, within a factor of three; MacDonald *et al.* 1996; Smith *et al.* 1996) the median lethal concentrations for several of these species. For fluoranthene, Suedel and Rodgers (1993) reported 10-day EC_{50}s of 4.2–15.0 mg/kg, 2.3–7.4 mg/kg, and 3.0–8.7 mg/kg for *D. magna, H. azteca*, and *C. tentans*, respectively. The lower of the values reported for each species are comparable to the PEC for fluoranthene that was derived in this study (*i.e.*, 2.23 mg/kg). Much higher toxicity thresholds have been reported in other studies (*e.g.*, Kane Driscoll *et al.* 1997; Kane Driscoll and Landrum 1997), but it is likely that these results were influenced by the lighting conditions under which the tests were conducted. Although this evaluation was made with limited data, the results suggest that the consensus-based SQGs are comparable to the acute toxicity thresholds that have been obtained from spiking studies.

A second approach—to identify concentrations of sediment-associated contaminants that cause or contribute to toxicity—was to compare our consensus-based PECs to equilibrium partitioning values (Swartz 1999; MacDonald *et al.* 1999). The equilibrium partitioning (EqP) approach provides a theoretical basis for deriving sediment quality guidelines for the protection of freshwater organisms (Di Toro *et al.* 1991; Zarba 1992). Using this approach, the US EPA (1997a) developed SQGs that are intended to represent chronic toxicity thresholds for various sediment-associated contaminants, primarily nonionic organic substances. The concentrations of these contaminants are considered to be sufficient to cause or substantially contribute to sediment toxicity when they exceed the EqP-based SQGs (Berry *et al.* 1996). To evaluate the extent to which the consensus-based SQGs are causally based, the PECs were compared to the chronic toxicity thresholds that have been developed previously using the EqP approach (see Table 2). The results of this evaluation indicate that the consensus-based PECs are generally comparable to the EqP-based SQGs (*i.e.*, within a factor of three; MacDonald *et al.* 1996; Smith *et al.* 1996). Therefore, the consensus-based PECs also define concentrations of sediment-associated contaminants that are sufficient to cause or substantially contribute to sediment toxicity.

Summary

Consensus-based SQGs were derived for 28 common chemicals of concern in freshwater sediments. For each chemical substance, two consensus-based SQGs were derived from the published SQGs. These SQGs reflect the toxicity of sediment-associated contaminants when they occur in mixtures with other contaminants. Therefore, these consensus-based SQGs are likely to be directly relevant for assessing freshwater sediments that are influenced by multiple sources of contaminants. The results of the evaluations of predictive ability demonstrate that the TECs and PECs for most of these chemicals, as well as the PEC quotients, provide a reliable basis for classifying sediments as not toxic and toxic. In addition, positive correlations between sediment chemistry and sediment toxicity indicate that many of these sediment-associated contaminants are associated with the effects that were observed in field-collected sediments. Furthermore, the level of agreement between the available dose-response data, the EqP-based SQGs, and the consensus-based SQGs indicates that sediment-associated contaminants are likely to cause or substantially contribute to, as opposed to simply be associated with, sediment toxicity at concentrations above the PECs.

Overall, the results of the various evaluations demonstrate that the consensus-based SQGs provide a unifying synthesis of the existing SQGs, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures (Swartz 1999). As such, the SQGs can be used to identify hot spots with respect to sediment contamination, determine the potential for and spatial extent of injury to sediment-dwelling organisms, evaluate the need for sediment remediation, and support the development of monitoring programs to further assess the extent of contamination and the effects of contaminated sediments on sediment-dwelling organisms. These applications are strengthened when the SQGs are used in combination with other sediment quality assessment tools (*i.e.*, sediment toxicity tests, bioaccumulation assessments, benthic invertebrate community assessments; Ingersoll *et al.* 1997). In these applications, the TECs should be used to identify sediments that are unlikely to be adversely affected by sediment-associated contaminants. In contrast, the PECs should be used to identify sediments that are likely to be toxic to sediment-dwelling

organisms. The PEC quotients should be used to assess sediment that contain complex mixtures of chemical contaminants.

The consensus-based SQGs described in this paper do not consider the potential for bioaccumulation in aquatic organisms nor the associated hazards to the species that consume aquatic organisms (*i.e.*, wildlife and humans). Therefore, it is important to use the consensus-based SQGs in conjunction with other tools, such as bioaccumulation-based SQGs, bioaccumulation tests, and tissue residue guidelines, to evaluate more fully the potential effects of sediment-associated contaminants in the environment. Future investigations should focus of evaluating the predictive ability of these sediment assessment tools on a species- and endpoint-specific basis for various geographic areas.

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KDHE Kansas Surface Water Quality Standards, Tables of Numeric Criteria (December 2004)

KANSAS SURFACE WATER QUALITY STANDARDS

Tables of Numeric Criteria

Prepared by The Kansas Department of Health and Environment

Bureau of Water

December 6, 2004

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Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria.

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
RADIONUCLIDES (pCi/L)						
gross beta radioactivity	a	a	a	a	a	50
gross alpha particles including radium-226,but not radon or uranium	a	a	a	a	a	15
radium 226 and 228 combined	a	a	a	a	a	5
strontium 90	a	a	a	a	a	8
tritium	a	a	a	a	a	20,000
METALS (µg/L)						
antimony, total	88	30	a	a	640	6
arsenic, total	340	150	200	100	20.5	10
arsenic (III)	360	50	a	a	b	b
arsenic (V)	850	48	a	a	a	a
barium	a	a	a	a	a	1,000
beryllium, total	a	a	a	a	a	4
boron, total	a	a	5,000	750	a	a
cadmium, total	table 1b	table 1b	20	10	170	5
chromium, total	a	40	1,000	100	a	100
chromium (III)	table 1b	table 1b	a	a	3,433,000	50
chromium (VI)	16	11	a	a	3,400	50
copper, total	table 1b	table 1b	500	200	a	1,300
lead, total	table 1b	table 1b	100	5,000	a	15
mercury, total	1.4	0.77	10	a	0.146	b
nickel, total	table 1b	table 1b	500	200	4,600	610
selenium, total	20	5	50	20	4,200	170
selenium (V)	11.2	a	a	a	a	a
silver, total	table 1b	a	a	a	a	50
thallium, total	1,400	40	a	a	b	2
zinc, total	table 1b	table 1b	25,000	2,000	26,000	7,400
OTHER INORGANIC SUBSTANCES (µg/L)						
ammonia	table 1c	table 1c	a	a	a	a
asbestos (µfibers/L)	a	a	a	a	a	7,000,000
Chloride	860,000	c	a	a	a	250,000
chlorine, total residual	19	11	a	a	a	a
cyanide (free)	22	5.2	a	a	220,000	200
Fluoride	a	a	2,000	1,000	a	2,000
nitrate (as N)	a	a	a	a	a	10,000
nitrite + nitrate (as N)	a	a	100,000	a	a	10,000
phosphorus, elemental (white)	a	0.1	a	a	a	a

Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria (continued).

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
sulfate	a	a	1,000,000	a	a	250,000
ORGANIC SUBSTANCES (µg/L)						
Benzenes.....						
aminobenzene (analine)	14	6.7	a	a	a	a
benzene	5,300	a	a	a	51	5
chlorobenzene	250	50	a	a	1,600	130
dichlorobenzenes, total	1,120	763	a	a	2,600	a
o-dichlorobenzene	1,120	763	a	a	2,600	600
m-dichlorobenzene	1,120	763	a	a	960	b
p-dichlorobenzene	a	a	a	a	2,600	75
other chlorinated benzenes, total	250	50	a	a	a	a
1,2,4-trichlorobenzene	250	a	a	a	940	260
1,2,4,5-tetrachlorobenzene	250	50	a	a	1.1	0.97
pentachlorobenzene	250	50	a	a	1.5	1.4
hexachlorobenzene	6.0	3.7	a	a	0.00029	b
ethylbenzene	32,000	a	a	a	28,712	700
nitrobenzene	27,000	a	a	a	690	b
pentachloronitrobenzene	250	50	a	a	a	a
vinylbenzene (styrene)	a	a	a	a	a	100
Ethers.....						
chloroalkyl ethers, total	238,000	a	a	a	a	a
bis(2-chloroethyl)ether	238,000	a	a	a	0.53	b
bis(2-chloroisopropyl)ether	238,000	a	a	a	65,000	b
bis(chloromethyl)ether	238,000	a	a	a	0.00029	0.00010
2-chloroethyl vinyl ether	360	120	a	a	a	a
halogenated ethers, total	360	122	a	a	a	a
chloromethyl methyl ether	238,000	a	a	a	0.00184	a
4,4'-dibromodiphenyl ether	360	120	a	a	a	a
hexabromodiphenyl ether	360	120	a	a	a	a
nonabromodiphenyl ether	360	120	a	a	a	a
pentabromodiphenyl ether	360	120	a	a	a	a
tetrabromodiphenyl ether	360	120	a	a	a	a
tribromodiphenyl ether	360	120	a	a	a	a
Halogenated Hydrocarbons.....						
chlorinated ethanes						
1,2-dichloroethane	18,000	2,000	a	a	b	~~b~~
1,1,1-trichloroethane	18,000	a	a	a	173,077	200
1,1,2-trichloroethane	18,000	9,400	a	a	16	b
tetrachloroethanes, total	9,320	a	a	a	a	a
1,1,1,2-tetrachloroethane	9,320	a	a	a	a	a

Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria (continued).

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
1,1,2,2-tetrachloroethane	9,320	2,400	a	a	3.3	b
pentachloroethane	7,240	1,100	a	a	a	a
hexachloroethane	980	540	a	a	3.3	b
chlorinated ethylenes, total	11,600	a	a	a	a	a
1,1-dichloroethylene	11,600	a	a	a	7,100	b
cis-1,2-dichloroethylene	11,600	a	a	a	a	70
trans-1,2-dichloroethylene	11,600	a	a	a	140,000	100
trichloroethylene	45,000	21,900	a	a	30	5
tetrachloroethylene	5,280	840	a	a	3.3	5
chlorinated propanes/propenes						
1,2-dichloropropane	23,000	5,700	9.0	a	15	0.50
1,3-dichloropropene	6,600	244	a	a	14.1	b
Other Halogenated Hydrocarbons.....						
halogenated methanes, total	11,000	a	a	a	15.7	100
bromomethane	11,000	a	a	a	1,500	b
1,2-dibromoethane	a	a	a	a	a	0.05
tribromomethane(bromoform)	11,000	a	a	a	140	b
bis(2-chloroethoxy)methane	11,000	a	a	a	15.7	a
bromodichloromethane	11,000	a	a	a	17	b
bromochloromethane	11,000	a	a	a	15.7	a
bromotrichloromethane	11,000	a	a	a	15.7	a
dibromochloromethane	11,000	a	a	a	13	b
dibromochloropropane	a	a	a	a	15.7	0.2
dibromodichloromethane	11,000	a	a	a	15.7	a
dichlorodifluoromethane	11,000	a	a	a	15.7	a
dichloromethane(methylene chloride)	11,000	a	a	a	590	4.7
trichloromethane(chloroform)	28,900	1,240	a	a	470	b
tribromochloromethane	11,000	a	a	a	15.7	a
trichlorofluoromethane	11,000	a	a	a	15.7	a
tetrachloromethane(carbon tetrachloride)	35,200	a	a	a	b	5
di(2-ethylhexyl)adipate	a	a	a	a	a	500
hexachlorobutadiene	90	9.3	a	a	18	b
hexachlorocyclopentadiene	7	5.2	a	a	206	50
vinyl chloride	a	a	a	a	525	2
Miscellaneous Organics.....						
dioxin (2,3,7,8 TCDD)	0.01	0.00001	a	a	0.000000005	b
Isosphorone	117,000	a	a	a	b	b
polychlorinated biphenyls, total	2	0.014	a	a	0.000064	b
tributyltin oxide	0.149	0.026	a	a	a	a

Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria (continued).

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
Nitrogen Compounds.....						
nitrosamines, total	5,850	a	a	a	1.24	0.0008
N-nitrosodibutylamine	5,850	a	a	a	0.22	0.0063
N-nitrosodiethanolamine	5,850	a	a	a	1.24	a
N-nitrosodiethylamine	5,850	a	a	a	1.24	0.0008
N-nitrosodimethylamine	5,850	a	a	a	3.0	b
N-nitrosodiphenylamine	5,850	a	a	a	6.0	b
N-nitrosodi-n-propylamine	a	a	a	a	0.51	.005
N-nitrosopyrrolidine	5,850	a	a	a	34	0.016
acrylonitrile	7,550	2,600	a	a	0.25	b
benzidene	2,500	a	a	a	0.0002	b
3,3'-dichlorobenzidine	a	a	a	a	0.02	b
1,2-diphenyl hydrazine	270	a	a	a	0.20	b
Polynuclear Aromatic Hydrocarbons, total	a	a	a	a	0.0311	0.2
acenaphthene	1,700	520	a	a	990	670
acenaphthylene	a	a	a	a	0.0311	a
anthracene	a	a	a	a	40,000	b
benzo(a)anthracene	a	a	a	a	0.018	b
benzo(a)pyrene	a	a	a	a	0.018	b
benzo(b)fluoranthene	a	a	a	a	0.018	b
benzo(g,h,i)perylene	a	a	a	a	0.0311	a
benzo(k)fluoranthene	a	a	a	a	0.018	b
2-chloronaphthalene	a	a	a	a	1,600	1,000
chrysene	a	a	a	a	0.018	b
dibenzo(a,h)anthracene	a	a	a	a	0.018	b
fluoranthene	3,980	a	a	a	b	b
fluorene	a	a	a	a	5,300	b
ideno(1,2,3-cd)pyrene	a	a	a	a	0.018	b
naphthalene	2,300	620	a	a	a	a
phenanthrene	30	6.3	a	a	0.0311	a
pyrene	a	a	a	a	4,000	b
Phthalate Esters						
phthalates, total	940	3	a	a	a	a
butylbenzyl phthalate	a	a	a	a	1,900	1,500
di(2-ethylhexyl) phthalate	400	360	a	a	b	b
dibutyl phthalate	940	3	a	a	b	b
diethyl phthalate	a	a	a	a	b	17,000
dimethyl phthalate	940	3	a	a	1,100,000	b
Phenolic Compounds.....						
phenol	10,200	2,560	a	a	1,700,000	b
2,4-dimethyl phenol	1,300	530	a	a	850	380

Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria (continued).

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
chlorinated phenols						
2-chlorophenol	4,380	2,000	a	a	150	81
3-chlorophenol	a	a	a	a	29,000	a
2,4-dichlorophenol	2,020	365	a	a	b	b
2,4,5-trichlorophenol	100	63	a	a	3,600	1,800
2,4,6-trichlorophenol	a	970	a	a	2.4	b
pentachlorophenol	table 1b	table 1b	a	a	3.0	b
3-methyl-4-chlorophenol	30	a	a	a	a	a
nitrophenols, total	230	150	a	a	a	a
2,4-dinitrophenol	a	a	a	a	5,300	b
4,6-dinitro-o-cresol	a	a	a	a	280	b
Toluenes.....						
toluene	17,500	a	a	a	b	1,000
dinitrotoluenes, total	330	230	a	a	9.1	a
2,4-dinitrotoluene	330	230	a	a	3.4	b
xylene	a	a	a	a	a	10,000
PESTICIDES (µg/L)						
acrolein	68	21	a	a	290	190
acrylamide	a	a	a	a	a	0.01
alachlor (lasso)	760	76	100	a	a	2
aldicarb	a	a	a	a	a	3
aldicarb sulfone	a	a	a	a	a	2
aldicarb sulfoxide	a	a	a	a	a	3
aldrin	3	0.001	1	a	0.00005	b
atrazine (aatrex)	170	3	a	a	a	3
bromoxynil (MCPA)	a	a	20	a	a	a
carbaryl (sevin)	a	0.02	100	a	a	a
carbofuran (furadan)	a	a	100	a	a	40
chlordane	2.4	0.0043	3	a	0.00081	b
chlorpyrifos	0.083	0.041	100	a	a	a
2,4-D	a	a	a	a	a	100
dacthal (DCPA)	a	14,300	a	a	a	a
dalapon	a	110	a	a	a	200
diazinon (spectracide)	a	0.08	100	a	a	a
DDT and Metabolites.....						
4,4'-DDE (p,p=-DDE)	1,050	a	a	a	0.00022	b
4,4'-DDD (p,p=-DDD)	a	a	a	a	0.00031	b
DDT, total	1.1	0.001	50	a	0.000024	b
dieldrin	0.24	0.056	1	a	0.000054	b
dinoseb (DNBP)	a	a	a	a	a	7
diquat	a	a	a	a	a	20
disulfoton (disyston)	a	a	100	a	a	a
endosulfan, total	0.22	0.056	a	a	159	b
alpha-endosulfan	0.22	0.056	a	a	89	62

Table 1a. Aquatic Life, Agriculture, And Public Health Designated Uses Numeric Criteria (continued).

USE CATEGORY						
	AQUATIC LIFE		AGRICULTURE		PUBLIC HEALTH	
PARAMETER	ACUTE	CHRONIC	LIVESTOCK	IRRIGATION	FOOD PROCUREMENT	DOMESTIC WATER SUPPLY
beta-endosulfan	0.22	0.056	a	a	89	62
endosulfan sulfate	a	a	a	a	b	b
endothall	a	a	a	a	a	110
endrin	0.086	0.036	0.5	a	0.81	0.76
endrin aldehyde	a	a	a	a	0.30	b
epichlorohydrin	a	a	a	a	a	4
ethylene dibromide	a	a	a	a	a	0.05
fenchlorfos (ronnel)	a	a	100	a	a	a
glyphosate (roundup)	a	a	a	a	a	700
guthion	a	0.010	100	a	a	a
heptachlor	0.52	0.0038	0.1	a	0.000079	b
heptachlor epoxide	0.52	0.0038	0.1	a	b	b
hexachlorocyclohexane	100	a	a	a	0.0414	0.0123
alpha-HCH	100	a	a	a	0.0049	b
beta-HCH	100	a	a	a	b	b
delta-HCH	100	a	a	a	a	a
gamma-HCH (lindane)	0.95	0.08	5	a	0.0625	b
technical-HCH	a	a	a	a	0.0414	a
malathion	a	0.10	100	a	a	a
methoxychlor	a	0.03	1,000	a	a	40
methyl parathion	a	a	100	a	a	a
metribuzin (sencor)	a	100	a	a	a	a
mirex	a	0.001	a	a	0.000097	a
oxamyl (vydate)	a	0.001	a	a	a	200
parathion	0.065	0.013	100	a	a	a
picloram (tordon)	a	a	a	a	a	500
propachlor (ramrod)	a	8	a	a	a	a
simazine (princep)	a	a	10	a	a	4
toxaphene	0.73	0.0002	5	a	0.00028	b
2,4,5-T	a	a	2	a	a	a
2,4,5-TP (silvex)	a	a	a	a	a	10

a - criterion not available
b - US EPA has promulgated criterion for Kansas under the Code of Federal Regulations, Title 40, part 131.36
c - criterion under investigation

Table 1b. Hardness-Dependent Aquatic Life Support Criteria.

Formulae for calculation of hardness-dependent aquatic life support criteria for chromium III and total cadmium, total copper, total lead, total nickel, total silver and total zinc and pH-dependent aquatic life support criteria for pentachlorophenol. A WER value of 1.0 is applied in the hardness-dependent equations for total metals unless a site-specific WER has been determined and adopted by the department in accordance with K.A.R. 28-16-28e(a) and K.A.R. 28-16-28f(f). Hardness values in metal formulae are entered in units of mg/L as $CaCO_3$. Pentachlorophenol formulae apply only over the pH range 6.5-8.5.

CADMIUM (ug/L):
acute criterion = WER[EXP[(1.0166(LN(hardness)))-3.924]]
chronic criterion = WER[EXP[(0.7409(LN(hardness)))-4.719]]

CHROMIUM III (ug/L):
acute criterion = WER[EXP[(0.819*(LN(hardness)))+3.7256]]
chronic criterion = WER[EXP[(0.819*(LN(hardness)))+0.6848]]

COPPER (ug/L):
acute criterion = WER[EXP[(0.9422*(LN(hardness)))-1.700]]
chronic criterion = WER[EXP[(0.8545*(LN(hardness)))-1.702]]

LEAD (ug/L):
acute criterion = WER[EXP[(1.273*(LN(hardness)))-1.460]]
chronic criterion = WER[EXP[(1.273*(LN(hardness)))-4.705]]

NICKEL (ug/L):
acute criterion = WER[EXP[(0.846*(LN(hardness)))+2.255]]
chronic criterion = WER[EXP[(0.846*(LN(hardness)))+0.0584]]

PENTACHLOROPHENOL (ug/L):
acute criterion = EXP[(1.005*pH)-4.830]
chronic criterion = EXP[(1.005*pH)-5.290]

SILVER (ug/L):
acute criterion = WER[EXP[(1.72*(LN(hardness)))-6.59]]

ZINC (ug/L):
acute criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]
chronic criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]

Tab1e 1c. pH-Dependent Acute Aquatic Life Criteria For Total Ammonia.

Total ammonia as N, mg/L

ACUTE AQUATIC LIFE CRITERIA FOR AMMONIA, mg/L	
pH	CRITERIA
6.5	48.8
6.6	46.8
6.7	44.6
6.8	42.0
6.9	39.1
7.0	36.1
7.1	32.8
7.2	29.5
7.3	26.2
7.4	23.0
7.5	19.9
7.6	17.0
7.7	14.4
7.8	12.1
7.9	10.1
8.0	8.40
8.1	6.95
8.2	5.72
8.3	4.71
8.4	3.88
8.5	3.20
8.6	2.65
8.7	2.20
8.8	1.84
8.9	1.56
9.0	1.32

Tab1e 1d. pH- And Temperature-Dependent Chronic Aquatic Life Criteria For Total Ammonia Early Life Stages Of Fish Present.

Total ammonia as N, mg/L

CHRONIC AQUATIC LIFE CRITERIA FOR AMMONIA, EARLY LIFE STAGES PRESENT, mg/L										
pH	TEMPERATURE, °C									
	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

Tab1e 1e. pH- And Temperature-Dependent Chronic Aquatic Life Criteria For Total Ammonia Early Life Stages Of Fish Absent.

Total ammonia as N, mg/L.

CHRONIC AQUATIC LIFE CRITERIA FOR AMMONIA, EARLY LIFE STAGES ABSENT*, mg/L								
pH	TEMPERATURE, °C							
	0-7	8	9	10	11	12	13	14**
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684
8.9	0.917	0.860	0.806	0.456	0.709	0.664	0.623	0.584
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503

*Early life stage absent criteria will apply to all Kansas surface waters during the months November through February except in surface water segments listed in Table 1f. The application of early life stage absent criteria outside of the months November through February shall require a segment-specific examination of the surface water for the presence of early life stages of fish.

** At 15 °C and above, the criterion for early life stages absent is equivalent to the criterion for early life stages present.

Table 1f. Surface Water Segments Where Early Life Stages Absent Chronic Aquatic Life Criteria Are Not Applicable.

SURFACE WATER	BASIN	SUBBASIN	HYDROLOGIC UNIT CODE	SEGMENT NUMBER
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	1
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	2
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	3
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	4
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	5
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	18
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	19
Kansas River	Kansas Lower Republican	Lower Kansas	10270104	21 From Bowersock dam east to segment 19
Missouri River	Missouri	Tarkio-Wolf	10240005	1
Missouri River	Missouri	Tarkio-Wolf	10240005	2
Missouri River	Missouri	Tarkio-Wolf	10240005	19
Missouri River	Missouri	Tarkio-Wolf	10240005	20
Missouri River	Missouri	Tarkio-Wolf	10240005	21
Missouri River	Missouri	Independence-Sugar	10240011	1
Missouri River	Missouri	Independence-Sugar	10240011	2
Missouri River	Missouri	Independence-Sugar	10240011	4
Missouri River	Missouri	Independence-Sugar	10240011	5
Missouri River	Missouri	Independence-Sugar	10240011	7
Missouri River	Missouri	Independence-Sugar	10240011	9
Missouri River	Missouri	Independence-Sugar	10240011	11
Missouri River	Missouri	Independence-Sugar	10240011	13
Missouri River	Missouri	Independence-Sugar	10240011	15
Missouri River	Missouri	Independence-Sugar	10240011	19

Table 1g. Temperature, Dissolved Oxygen, And pH Numeric Aquatic Life Criteria.

AQUATIC LIFE USE	DISSOLVED OXYGEN (DO)	PH	TEMPERATURE
SPECIAL	5.0 mg/L[a]	6.5-8.5[b]	32°C[c]
EXPECTED	5.0 mg/L[a]	6.5-8.5[b]	32°C[c]
RESTRICTED	5.0 mg/L[a]	6.5-8.5[b]	32°C[c]

a - The concentration of dissolved oxygen in surface waters shall not be lowered by the influence of artificial sources of pollution.
b - pH range outside the zone of initial dilution.
c - Beyond the zone of initial dilution a discharge shall not elevate the temperature of a receiving surface water above this temperature, except as provided in paragraph (c)(2)(E)(ii).

Table 1h. Natural Background Concentrations.

BASIN	WATERBODY	HUC 8	SEGMENT	POLLUTANT	NATURAL BACKGROUND CONCENTRATION
Cimarron	Cimarron River	11040006	1; starting at state line and traveling upstream toward Hayne.	Chloride	1,010 mg/L
Cimarron	Crooked Creek	11040007	1 and 2; starting at state line and traveling upstream to Copeland	Chloride	1,200 mg/L
Cimarron	Stumpie Arroyo	11040007	1247	Chloride	1,200 mg/L
Cimarron	Spring Creek	11040007	3	Chloride	1,200 mg/L
Cimarron	Remuda Creek	11040007	4	Chloride	1,200 mg/L
Cimarron	Cimarron River	11040008	1, 5, 11; starting at confluence with Bluff Creek and traveling upstream to the Oklahoma border.	Sulfate	465 mg/L
Cimarron	Cimarron River	11040008	1, 5, 11; starting at confluence with Bluff Creek and traveling upstream to the Oklahoma border.	Chloride	900 mg/L
Cimarron	Bluff Creek	11040008	2 & 13; starting at confluence with the Cimarron River and traveling upstream toward Minneola.	Sulfate	350 mg/L
Kansas-Lower Republican	Buffalo Creek	10250017	29 and 37; starting at the confluence with Republican River and traveling upstream to Mankato	Chloride	590 mg/L
Kansas-Lower Republican	Upper Kansas River	10270701	1, 3, 4, 6 and 7; starting at the confluence with the Big Blue River and traveling upstream to Junction City	Chloride	275 mg/L
Lower Arkansas	Rattlesnake Creek	11030009	1; above the Little Salt Marsh in Quivira National Wildlife Refuge QNWR	Chloride	1,400 mg/L
Lower Arkansas	Rattlesnake Creek	11030009	1; below the Little Salt Marsh in QNWR	Chloride	3,660 mg/L
Lower Arkansas	Rattlesnake Creek	11030009	1; below the Little Salt Marsh in QNWR	Sulfate	455 mg/L
Lower Arkansas	Peace Creek	11030010	6; starting at the confluence with the Arkansas River and traveling upstream to Stafford.	Chloride	1,800 mg/L

Table 1h. Natural Background Concentrations (continued).

BASIN	WATERBODY	HUC 8	SEGMENT	POLLUTANT	NATURAL BACKGROUND CONCENTRATION
Lower Arkansas	Arkansas River	11030013	3, 9, 18; starting at the confluence with Ninnescah River and ending at the confluence with the Little Arkansas River.	Sulfate	350 mg/L
Lower Arkansas	Slate Creek WA Watershed	11030013	Conservation Pool: Area: 26 acres Maximum Depth: 0.3 meters	Chloride	27,590 mg/L
Lower Arkansas	Slate Creek WA Watershed	11030013	Conservation Pool: Area: 26 acres Maximum Depth: 0.3 meters	Sulfate	2,500 mg/L
Lower Arkansas	Salt Fork Arkansas River	11060002	4, 6, 8, 10, 11, 13, and 15; starting at Kansas/Oklahoma state line and traveling upstream to west-central Comanche County.	Chloride	305 mg/L
Lower Arkansas	Salt Fork Arkansas River	11060002	4, 6, 8, 10, 11, 13, and 15; starting at Kansas/Oklahoma stateline and traveling upstream to west-central Comanche County.	Sulfate	730 mg/L
Lower Arkansas	Mule Creek	11060002	7; starting at the confluence with the Salt Fork Arkansas River; Headwaters in South-Central Kiowa County.	Sulfate	310 mg/L
Lower Arkansas	Medicine Lodge River	11060003	2; starting at the Oklahoma border and traveling upstream toward the confluence with Elm Creek.	Sulfate	450 mg/L
Lower Arkansas	Medicine Lodge River	11060003	8; starting at the confluence with Turkey Creek; Headwaters near Greensburg, in Kiowa County.	Sulfate	300 mg/L
Lower Arkansas	North Branch, Medicine Lodge River	11060003	24	Sulfate	300 mg/L
Lower Arkansas	Thompson Creek	11060003	26	Sulfate	300 mg/L
Lower Arkansas	Otter Creek	11060003	25	Sulfate	300 mg/L
Lower Arkansas	Soldier Creek	11060003	27	Sulfate	300 mg/L
Neosho	Doyle Creek	11070202	21	Sulfate	370 mg/L
Neosho	South Cottonwood River	11070202	17 and 18	Sulfate	840 mg/L
Neosho	French Creek	11070202	16	Sulfate	1,045 mg/L
Neosho	Clear Creek	11070202	4 and 5	Sulfate	290 mg/L
Upper Arkansas	Arkansas River	11030001	1, 3, 5, 7 & 9 from stateline to small stream E of Garden City.	Sulfate	1,875 mg/L
Upper Arkansas	Arkansas River	11030003	1	Sulfate	350 mg/L
Upper Arkansas	Arkansas River	11030004	11	Sulfate	350 mg/L
Upper Arkansas	Arkansas River	11030004	10 and 6	Sulfate	550 mg/L
Upper Arkansas	Arkansas River	11030004	10; beginning at the confluence of Mulberry Creek in east-central Ford County and ending at the confluence with Coon Creek.	Fluoride	1.45 mg/L

Table 1h. Natural Background Concentrations (continued).

BASIN	WATERBODY	HUC 8	SEGMENT	POLLUTANT	NATURAL BACKGROUND CONCENTRATION
Upper Republican	South Fork Republican River	10250003	2 and 4 (S. Fk. Republican River) starting at the Kansas-Nebraska state line and traveling upstream to southwest Cheyenne County and the Kansas-Colorado stateline.	Fluoride	1.45 mg/L
Upper Republican	Big Timber Cr	10250003	61	Fluoride	1.45 mg/L
Upper Republican	Delay Cr	10250003	66	Fluoride	1.45 mg/L
Upper Republican	Hackberry Cr	10250003	3	Fluoride	1.45 mg/L
Upper Republican	Bluff Cr	10250003	70	Fluoride	1.45 mg/L
Upper Republican	Valley Cr	10250003	69	Fluoride	1.45 mg/L
Upper Republican	Spring Cr	10250003	67	Fluoride	1.45 mg/L
Upper Republican	Sand Cr	10250003	68	Fluoride	1.45 mg/L
Upper Republican	South Fork Republican River	10250003	6, 7 and 9 (S. Fk. Republican River) starting at the Kansas-Nebraska state line and traveling upstream to southwest Cheyenne County and the Kansas-Colorado stateline.	Fluoride	1.20 mg/L
Upper Republican	Drury Cr	10250003	60	Fluoride	1.20 mg/L
Upper Republican	Crosby Cr	10250003	72	Fluoride	1.20 mg/L
Upper Republican	Battle Cr	10250003	71	Fluoride	1.20 mg/L
Upper Republican	Cowpe Cr	10250003	8	Fluoride	1.20 mg/L
Walnut	Whitewater River	11030017	18, 19, 21, and 23	Sulfate	390 mg/L
Walnut	Whitewater River, West Branch	11030017	22	Sulfate	390 mg/L
Walnut	Whitewater River, East Branch	11030017	24 and 25	Sulfate	390 mg/L
Walnut	Whitewater Creek	11030017	34	Sulfate	390 mg/L
Walnut	Prairie Creek	11030017	35	Sulfate	390 mg/L
Walnut	Wildcat Creek	11030017	26	Sulfate	390 mg/L
Walnut	Sand Creek	11030017	29	Sulfate	390 mg/L

Table 1h. Natural Background Concentrations (continued).

BASIN	WATERBODY	HUC 8	SEGMENT	POLLUTANT	NATURAL BACKGROUND CONCENTRATION
Walnut	W. Wildcat Creek	11030017	28	Sulfate	390 mg/L
Walnut	Gypsum Creek	11030017	30	Sulfate	390 mg/L
Walnut	E. Br. Whitewater Creek	11030017	31	Sulfate	390 mg/L
Walnut	Walnut Creek	11030017	44	Sulfate	390 mg/L
Walnut	Fourmile Creek	11030017	20	Sulfate	390 mg/L
Walnut	Dry Creek	11030017	32	Sulfate	390 mg/L
Walnut	Henry Creek	11030017	33	Sulfate	390 mg/L
Walnut	Eightmile Creek	11030018	30	Sulfate	520 mg/L

Table 1i. *Escherichia coli* Criteria For Classified Stream Segments.

USE	Colony Forming Units (CFUs)/100mL	
PRIMARY CONTACT RECREATION	Geometric Mean April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31
Class A	160	2358
Class B	262	2358
Class C	427	3843
SECONDARY CONTACT RECREATION	Geometric Mean Jan. 1 – Dec. 31	
Class a	2358	
Class b	3843	

Table 1j. *Escherichia coli* Criteria For Classified Surface Waters Other Than Classified Stream Segments.

USE	Colony Forming Units (CFUs)/100mL			
PRIMARY CONTACT RECREATION	Geometric Mean April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31	Single Sample Maximum April 1 – Oct. 31	Single Sample Maximum Nov. 1 – March 31
Swimming Beach	160	800	732	3655
Public Access	262	1310	1198	6580
Restricted Access	427	2135	1950	9760
SECONDARY CONTACT RECREATION	Geometric Mean Jan. 1 – Dec. 31		Single Sample Maximum Jan. 1 – Dec. 31	
Public Access	2135		9760	
Restricted Access	2135		9760	

NOAA SQuiRTs
(November 2008)

Screening Quick Reference Tables

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

This set of NOAA Screening Quick Reference Tables, or SQuiRTs, presents screening concentrations for inorganic and organic contaminants in various environmental media. Additional reference material, such as guidelines for sample preservation, are also included.

NOAA identifies potential impacts to coastal resources and habitats likely to be affected by hazardous wastes. To screen for substances which may threaten natural resources of concern to NOAA, environmental concentrations are compared to these screening levels. These tables are intended for preliminary screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels. NOAA does not endorse their use for any other purposes. Screening levels are reported with the number of significant figures they were originally reported with.

In this new version, column headings link to OR&R's web site wherebrief descriptions of the benchmark may be found. However, detailed guidance on the recommended application of various screening guidelines is provided in the original sources (listed in each SQuiRT section, with web links for many). Users of the SQuiRT cards are strongly encouraged to review supporting documentation to determine appropriateness for their specific use.

The SQuiRT card set has been re-organized from earlier versions to accommodate expansion. Benchmarks from numerous new sources have been incorporated, and the list of analytes vastly increased. The SQuiRT cards present benchmarks representing different degrees of protectiveness. Multiple benchmarks are also provided in many cases: the user is advised to review the derivation of any particular benchmark before selecting a specific value. Information is still presented in sections, with *new sections* appearing in this expanded version:

- Inorganics in Sediment (freshwater and marine)
- Inorganics in Water (groundwater and surface water)
- Organics in Water and Soil
- *Toxic Equivalency Factors*
- Guidelines for Sample Collection & Storage
- Analytical Methods for Inorganics
- Inorganics in Soil
- Organics in Sediment
- *PCB Composition*
- *Composition by Carbon Range*
- Analytical Methods for Organics

Footnotes within each SQuiRT section which appear at the bottom of the page are only to aid in deciphering the nature of specific entries. Due to space constraints, notations which relate to the source for individual values are explained at the end of the section. Organic chemicals are now listed alphabetically, without categorization. A few synonyms are provided, but CAS numbers are also presented to aid in identifying and finding specific analytes. Except as noted, all concentrations in the SQuiRT cards are in parts per billion.

For surface water samples, because releases from hazardous waste sites are often continuous and long-term, concentrations are most often compared directly with chronic benchmarks, when available. Groundwater concentrations are also screened against chronic benchmarks. However, suitable site-specific dilution factors should be applied to allow for dilution upon migration and discharge of groundwater to surface water. The SQuiRT cards present U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs), applicable to drinking water sources and secondary MCLs applicable to groundwater, supplemented by values from Canada and the United Nations World Health Organization.

Preference for surface water and groundwater benchmarks is given to U.S. EPA Ambient Water Quality Criteria (AWQC). This is generally followed by Tier II Secondary Acute Values (SAVs) or available standards and guidelines from other regulatory agencies. Tier II SAVs are derived using a similar approach to AWQC, but do not have sufficient supporting data for full criteria calculation. Lowest Observable Effect Levels (LOELs) were originally published by EPA with AWQC. Around 2000, EPA stopped publishing these values, however, LOELs are reproduced here when no other benchmark is available, because in many instances, they formed the basis for state standards.

For many trace elements, AWQC are now expressed in terms of the "dissolved" fraction, which is essentially defined operationally as a filtered fraction. Likewise, the toxicity of many trace elements is related to the water hardness, and the values presented are for a default hardness of 100 mg/L $CaCO_3$. Equations are provided in the SQuiRT cards to calculate the exact criteria for a given hardness, or, to convert from unfiltered, total concentrations to "dissolved" fractions.

Screening Quick Reference Table for Inorganics in Sediment

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
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Analyte		FRESHWATER SEDIMENT									MARINE SEDIMENT						
All concentrations in parts per billion dry weight unless specified otherwise		"Background" [1]	ARCS *H. azteca* TEL [2]	TEC [3]	TEL [3]	LEL [4]	PEC [3]	PEL [3]	SEL [4]	UET [1]	T_{20} [5]	TEL [6]	ERL [6]	T_{50} [5]	PEL [6]	ERM [6]	AET [7]
Predicted Toxicity Gradient:		Increasing →									Increasing →						
Aluminum (%)	Al	0.26%	2.55%														1.8% N
Antimony	Sb	160								3,000 M	630			2,400			9,300 E
Arsenic	As	1,100	10,798	9,790	5,900	6,000	33,000	17,000	33,000	17,000 I	7,400	7,240	8,200	20,000	41,600	70,000	35,000 B
Barium	Ba	700										130,100#					48,000 A
Cadmium	Cd	100-300	583	990	596	600	4,980	3,530	10,000	3,000 I	380	680	1,200	1,400	4,210	9,600	3,000 N
Chromium	Cr	7,000-13,000	36,286	43,400	37,300	26,000	111,000	90,000	110,000	95,000 H	49,000	52,300	81,000	141,000	160,000	370,000	62,000 N
Cobalt	Co	10,000				50,000+											10,000 N
Copper	Cu	10,000-25,000	28,012	31,600	35,700	16,000	149,000	197,000	110,000	86,000 I	32,000	18,700	34,000	94,000	108,000	270,000	390,000 MO
Iron (%)	Fe	0.99-1.8 %	18.84%			2%			4%	4% I							22% N
Lead	Pb	4,000-17,000	37,000	35,800	35,000	31,000	128,000	91,300	250,000	127,000 H	30,000	30,240	46,700	94,000	112,000	218,000	400,000 B
Manganese	Mn	400,000	630,000			460,000			1,100,000	1,100,000 I							260,000 N
Mercury	Hg	4-51		180	174	200	1,060	486	2,000	560 M	140	130	150	480	700	710	410 M
Nickel	Ni	9,900	19,514	22,700	18,000	16,000	48,600	36,000	75,000	43,000 H	15,000	15,900	20,900	47,000	42,800	51,600	110,000 EL
Selenium	Se	290															1,000 A
Silver	Ag	<500				500 +				4,500 H	230	730	1,000	1,100	1,770	3,700	3,100 B
Strontium	Sr	49,000															
Tin	Sn	5,000										48 *					> 3,400 N
Vanadium	V	50,000															57,000 N
Zinc	Zn	7,000-38,000	98,000	121,000	123,000	120,000	459,000	315,000	820,000	520,000 M	94,000	124,000	150,000	245,000	271,000	410,000	410,000 I
Lead 210 $^{bq}/_{g}$ dw						0.5 ^			< 9.7 ^								
Polonium 210 $^{bq}/_{g}$ dw						0.6 ^			< 8.7 ^								
Radium 226 $^{bq}/_{g}$ dw						0.1 ^			< 13 ^								
Sulfides										130,000 M							4,500 MO

\# - Based on SLC approach using sensitive species HC5%; ES&T 2005 39(14):5148-5156.
* - Based upon EQp approach using current AWQC CCC
^ - Based on SLC approach to derive LEL and SEL; Env'al Monitor & Ass'ment 2005 110:71-85
\+ - Carried over from Open Water disposal Guidelines; treated as if LEL for management decisions.

Bioassay endpoints: M – Microtox; B – Bivalve; E – Echinoderm larvae; O – Oyster larvae; A – Amphipod; N – Neanthes; L –Larval bioassay; plus, I – Infaunal community impacts

Sources

1 – Buchman, M. 1999. NOAA HAZMAT Report 99-1.
2 – EPA 905-R96-008
3 – Arch ET&C 2000, 39(1)20- TEL and PEL are also known as Canadian ISQGs and PELs
4 – Guidelines for the protection and management of aquatic sediment quality in Ontario Aug 1993
5 – ET&C 2002, 21(9)1993-
6 – Ecotox. 1996, 5(4):253-
7 – Chapter 173-204 WAC, 1991/95 as supplemented by WA Dept of Ecology staff with unpublished data.

Screening Quick Reference Table for Inorganics in Soil

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ANALYTE All concentrations in parts per billion dry weight unless specified otherwise		CAS Number	BACKGROUND [1]		DUTCH STANDARDS [2]		Eco-SSL [3]				Microbes [4]
			Mean	Range	Target	Intervention	Avian	Inverts	Mammals	Plants	
Aluminum	Al	7429905	4.70%	0.5- >10%						50,000 a	600,000
Antimony	Sb	7440360	480	bd-8,800	3,000	15,000		78,000	142 v	5,000 a	
Arsenic	As	7440382	5,200	bd-97,000	900 L	55,000	43,000	60,000 a	5,700 v	18,000	100,000
Barium	Ba	7440393	440,000	10,000-0.5%	160,000	625,000		330,000	1,040 v	500,000 a	3,000,000
Beryllium	Be	7440417	630	bd-15,000	1,100	30,000 S		40,000	1,060 v	10,000 a	
Boron	B	7440428	26,000	bd-300,000						500 a	20,000
Bromine	Br	7726956	560	bd-11,000	20,000					10,000 a	
Cadmium	Cd	7440439			800	12,000	770	20,000 a	2.22 v	4,000 a	20,000
Chromium III	Cr	7440473	< 37,000	1,000-0.2%	< 380 L	< 220,000 L	26,000	<400 a	34,000	< 1,000 a	< 10,000
Chromium VI	Cr	18540299	< 37,000		< 380 L	< 220,000 L		400 a	81,000	< 1,000 a	< 10,000
Cobalt	Co	7440484	6,700	bd-70,000	2,400 L	180,000 L	120,000		140 v	13,000	1,000,000
Copper	Cu	7440508	17,000	bd-700,000	3,400 L	96,000 L	28,000	50,000 a	5,400 v	70,000	100,000
Cyanide (total complex)	CN	57125			5,000	50,000 (pH>5)			1,330 v		
Cyanide (total free)	CN				1,000	20,000					
Fluorine	F	7782414	210,000	bd-0.37%	500,000					200,000 a	30,000
Iodine	I	7553562	750	bd-9,600						4,000 a	
Iron	Fe	7439896	1.80%	0.01- >10%							200,000
Lanthanum	La	7439910	30,000	bd-200,000							50,000
Lead	Pb	7439921	16,000	bd-700,000	55,000 L	530,000	11,000	500,000 a	53.7 v	50,000 a	900,000
Lithium	Li	7439932	20,000	bd-140,000						2,000 a	10,000
Manganese	Mn	7439965	330,000	bd-0.7%			4,300,000	450,000	4,000,000	220,000	100,000
Mercury	Hg	7439976	58	bd-4,600	300	10,000		100 a v		300 a	30,000
Mercury(methyl)		22967926			37 L	4,000 L		< 100 a v	1.58 v	< 300 a	
Molybdenum	Mo	7439987	590	bd-15,000	3,000	190,000 L				2,000 a	200,000
Nickel	Ni	7440020	13,000	bd-700,000	260 L	100,000 L	210,000	200,000 a	13,600 v	30,000 a	90,000
Selenium	Se	7782492	260	bd-4,300	700 L	100,000 S	1,2000	4,100	630	520	100,000
Silver	Ag	7440224				15,000 S	4,200		4,040 v	2,000 a	50,000
Strontium	Sr	7440246	120,000	bd-0.3%							
Sulfide		18496258							3.58 v		
Sulfur	S	7704349	0.12%	bd-4.8%							
Technetium	Tc	7440268								200 a	

1: bd – below detection
2: S – serious contamination level; L – Environmental Risk Limit

Screening Quick Reference Table for Inorganics in Soil

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ANALYTE All concentrations in parts per billion dry weight unless specified otherwise		CAS Number	BACKGROUND [1]		DUTCH STANDARDS [2]		Eco-SSL [3]				Microbes [4]
			Mean	Range	Target	Intervention	Avian	Inverts	Mammals	Plants	
Tellurium	Te	13494809				600,000					
Thallium	Tl	7440280	8,600	2,20-31,000	1,000	15,000 S			56.9 v	1,000 a	
Tin	Sn	7440315	890	bd-10,000	19,000 background	900,000 S			7,620 v	50,000 a	2,000,000
Titanium	Ti	7440326	0.224 %	0.007-2 %							1,000,000
Tin as Triphenyltin		668348				< 2,500					
Tungsten	W	7440337									400,000
Uranium	U	7440611	2,300	290-11,000						5,000 a	
Vanadium	V	7440622	58,000	bd-500,000	42,000	250,000 S	7,800		1,590 v	2,000 a	20,000
Zinc	Zn	7440666	48,000	bd-0.29%	16,000 L	350,000 L	46,000	6,620 v		50,000 a	100,000

Sources

1 – USGS Prof. Paper 1270, 1984. Mean is geometric mean of national data.

2 – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has not been done here.
Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel, 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water: Updated proposal for first series of compounds. Nat. Inst. Public Health and the Env., and subsequent updates as published elsewhere.
Min. Housing, Spatial Plan. And the Env., 2000. Annexes Circular on target values and intervention values for soil remediations.

3 – Entry is lower of either:
EPA Eco-SSLs, www.epa.gov/ecotox/ecossl/
a – ORNL Screening benchmark for earthworms and soil microorganisms: ORNL 1997a, ES/ER/TM-126/R2
v – EPA R5 Eco Screening levels soil - shrew or vole, www.epa.gov/reg5rcra/ca/

4 - ORNL 1997b, ES/ER/TM-85/R3.

1: bd – below detection
2: S – serious contamination level; L – Environmental Risk Limit

Screening Quick Reference Table for Inorganics in Water

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ELEMENT All concentrations in parts per billion unless specified otherwise		GROUND WATER [1]	SURFACE WATERS [2]			
			Freshwater		Marine	
			Acute	Chronic	Acute	Chronic
Aluminum	Al	50-200 *	pH 750	pH 87		
Antimony	Sb	6	88 p	30 p	1,500 p	500 p
Arsenic III	As^{+3}	<10		190 E		2.3 NZ
Arsenic V	As^{+5}	< 10	66 T	3.1 T	2,319 *	
Arsenic, Total	As	10	340	150	69	36
Barium	Ba	2,000	110 T	3.9 E	1,000 BC	200 BC
Beryllium	Be	4	35 T	0.66 T	1,500 BC	100 BC
Boron	B	5,000 C	30 T	1.6 T		1,200
Cadmium	Cd	5	2.0 †	0.25 †	40	8.8
Chromium III	Cr^{+3}	< 100	570 †	74 †	10,300 *	27.4 NZ
Chromium VI	Cr^{+6}	< 100	16	11	1,100	50
Chromium, Total	Cr	100				
Cobalt	Co		1,500 T	3.0 E		1 NZ
Copper	Cu	1,300	13 †	9 †	4.8	3.1
Fluoride	F	4,000	200 BC (hardness < 50)		1,500 BC	
Gallium	Ga			18 NZ		use 18 NZ
Iron	Fe	300 *		1,000	300 BC	50 BC
Lanthium	La			0.04 NZ		
Lead	Pb	15	65 †	2.5 †	210	8.1
Lithium	Li		260 T	14 T		
Manganese	Mn	50 *	2,300 T	80 E		100 BC
Mercury	Hg	2	1.4	0.77	1.8	0.94
Methyl Mercury			0.099 T	0.0028 T		
Molybdenum	Mo	70 W	16,000 T	34 NZ		23 NZ
Nickel	Ni	20 W	470 †	52 †	74	8.2
Phosphorus	P					0.1
Potassium	K		373,000 BC			
Selenium	Se	50	13-186 total	5 total	290	71
Silver	Ag	100 *	1.6 (½) †	0.36 T	0.95 (½)	
Strontium	Sr		15,000 T	1,500 T		
Thallium	Tl	2	110 T	0.03 NZ	2,130 *	17 NZ
Tin as TBT			0.46	0.072	0.42	0.0074

1: * – Secondary standard
2: pH – criteria is pH dependent ; p - proposed; † - hardness dependent; * - EPA LOEL ; (½) - CMC is halved to compare to 1985 Guideline derivation

Screening Quick Reference Table for Inorganics in Water

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All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

ELEMENT All concentrations in parts per billion unless specified otherwise		GROUND WATER [1]	SURFACE WATERS [2]			
			Freshwater		Marine	
			Acute	Chronic	Acute	Chronic
Tin as Di-N-Butyl			0.08 BC			
Tin as Triethyl			0.4 BC			
Tin as Triphenyl			0.022 BC		34 BC	
Titanium	Ti		2,000 BC			
Uranium	U	30	46 T	0.5 NZ	500 BC	100 BC
Vanadium	V		280 T	19 E		50 BC
Zinc (Zn)	Zn	5,000 *	120 †	120 †	90	81
Zirconium	Zr		310 T	17 T		
Hydrogen Sulfide			2		2	
Cyanide, free	CN	200	22	5.2	1	1

Freshwater criterion for certain elements (†) are expressed as a function of hardness (mg/L) in the water column. The values shown assume 100 mg/L. Values for a different hardness may be calculated using the following equations to arrive at a CMC or CCC for *filtered* samples. Hardness may range up to 400 mg/L as calcium carbonate. For hardness above this range, use 400 mg/L as the maximum value allowed.

For salinity between 1 and 10 ppt, use the more stringent of either fresh or marine values.

Sources

1 – Primary entry is the US EPA MCL value, followed by the WHO drinking water guidelines.
Maximum Contaminant Levels (MCLs): http://www.epa.gov/safewater/index.html
W – World Health Organization's (WHO) Drinking water guidelines: http://www.who.int/water_sanitation_health/dwq/en/
C – Canadian water Quality Guidelines: http://www.ec.gc.ca/CEQG-RCQE/English/Ceqg/Water/default.cfm

2 – Primary entry is the US Ambient Water Quality Criteria, followed by the lowest of Tier II SAVs or available standards and guidelines.
EPA Ambient water Quality Criteria (AWQC): http://www.epa.gov/waterscience/criteria/aqlife.html
T – Tier II Secondary Acute Value: http://www.esd.ornl.gov/programs/ecorisk/tools.html
BC – British Columbia Water Quality Guidelines (either working or recommended): http://www.env.gov.bc.ca/wat/wq/
NZ – Australian & New Zealand ECLs and Trigger values: ANZECC Oct 2000, Volume 1, The Guidelines. www.mfe.govt.nz/publications/
E – EcoUpdate: www.epa.gov/oswer/riskassessment/ecoup/

Lowest Observable Effect Levels (LOELs) previously published by EPA are also included since these essentially were the basis for many state standards.
EPA LOELs: EPA Water quality Criteria Summary, Office of Science & Technology, Health & Ecological Criteria Div., Ecological Risk Assessment Branch, 1991.
Full listings appeared in various Fed. Register notices and in EPA's Quality Criteria for Water, 1992.

1: * – Secondary standard
2: pH – criteria is pH dependent ; p - proposed; † - hardness dependent; * - EPA LOEL ; (½) - CMC is halved to compare to 1985 Guideline derivation

Screening Quick Reference Table for Inorganics in Water

These tables were developed for internal use for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

ELEMENT	HARDNESS CALCULATIONS – UNFILTERED FRESHWATER CRITERIA		UNFILTERED TO FILTERED CALCULATIONS		
	CMC	CCC	Fresh water CMC	Freshwater CCC	Marine CMC / CCC
Arsenic (As)			1	1	1
Cadmium (Cd)	$CMC = e^{1.0166\ [\ ln(hardness)] - 3.924}$	$CCC = e^{0.7409\ [\ ln(hardness)] - 4.719}$	CF = 1.136672 - 0.041838 [*ln*(hardness)]	CF = 1.101672 - 0.041838 [*ln*(hardness)]	CF = 0.994
Chromium III (Cr+3)	$CMC = e^{0.819\ [\ ln(hardness)] + 3.7256}$	$CCC = e^{0.819\ [\ ln(hardness)] + 0.6848}$	CF = 0.316	CF = 0.860	–
Chromium VI (Cr +6)			CF = 0.982	CF = 0.962	CF = 0.993
Copper (Cu)	$CMC = e^{0.9422\ [\ ln(hardness)] - 1.7}$	$CCC = e^{0.8545\ [\ ln(hardness)] - 1.702}$	CF = 0.960	CF = 0.960	CF = 0.83
Lead (Pb)	$CMC = e^{1.273\ [\ ln(hardness)] - 1.46}$	$CCC = e^{1.273\ [\ ln(hardness)] - 4.705}$	CF = 1.46203 - 0.145712 [*ln*(hardness)]	SAME AS CMC	CF = 0.951
Mercury (Hg)			CF = 0.85	CF = 0.85	CF = 0.85
Nickel (Ni)	$CMC = e^{0.846\ [\ ln(hardness)] + 2.255}$	$CCC = e^{0.846\ [\ ln(hardness)] + 0.0584}$	CF = 0.998	CF = 0.997	CF = 0.990
Selenium (Se)			–	–	CF = 0.998
Silver (Ag)	$CMC = e^{1.72\ [\ ln(hardness)] - 6.52}$	CCC — No criteria	CF = 0.85	–	CF = 0.85 / –
Zinc (Zn)	$CMC = e^{0.8473\ [ln(hardness)] + 0.884}$	$CCC = e^{0.8473\ [\ ln(hardness) + 0.884}$	CF = 0.978	CF = 0.986	CF = 0.946

Freshwater criterion for certain elements are expressed as a function of hardness (mg/L) in the water column. The values shown assume 100 mg/L. Values for a different hardness may be calculated using the above equations to arrive at a CMC or CCC for *filtered* samples. Hardness may range up to 400 mg/L as calcium carbonate. For hardness above this range, use 400 mg/L as the maximum value allowed.

Criteria for most metals are expressed as standards for samples filtered through 0.45 m filter (*i.e.*, "dissolved"). To convert unfiltered concentrations to filtered, multiply the unfiltered concentration value by the appropriate Conversion Factor (CF) above. For cadmium and lead, the conversion factor itself is hardness-dependent.

CMC: Criteria Maximum Concentration is the highest level for a 1-hour average exposure not to be exceeded more than once every three years, and is synonymous with “acute.”

CCC: for a 4-day average exposure not to be exceeded more than once every three years, and is synonymous with “chronic.”

Sources

EPA Ambient water Quality Criteria (AWQC): http://www.epa.gov/waterscience/criteria/aqlife.html

Screening Quick Reference Tables for Organics – Sediment

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ANALYTE All concentrations in parts per billion dry weight unless specified otherwise	CAS Number	FRESHWATER SEDIMENT								DUTCH Sediment[5]		MARINE SEDIMENT							Eco Tox EqP[9] @1%TOC
		ARCS *Hyalella* TEL[1]	TEL[2]	TEC[2]	LEL[3]	PEL[2]	PEC[2]	SEL[3]	UET[4] @1%TOC	Target	Intervention	T_{20}[6]	TEL[7]	ERL[7]	T_{50}[6]	PEL[7]	ERM[7]	AET[8]	
2,3,7,8-TCDD dioxin TEQs	1746016		0.00085 c			0.0215 c			0.0088†H		1 S		0.00085 c			0.0215 c		0.0036 N	
Acenaphthene	83329		6.71 c			88.9 c			290 M			19	6.71	16	116	88.9	500	130 E	
Acenaphthylene	208968		5.87 c			128 c			160 M			14	5.87	44	140	128	640	71 E	
Acrylonitrile	107131									0.07	100 S								
Aldrin	309002				2			80	40 I	0.06	1,700 LB							9.5 AE	
Aldrin + Dieldrin + Endrin	na									5	140 L								
Anthracene	120127	10	46.9 c	57.2	220	245 c	845	3,700	260 M	39 LB	1,600 LB	34	46.9	85.3	290	245	1,100	280 E	
Atrazine	1912249									0.2	710 LB								
BCH compounds (sum)	na									10	6,400 L								
Benz[a]anthracene	56553	15.72	31.7	108	320	385	1,050	14,800	500 I	25 L	2,500 L	61	74.8	261	466	693	1,600	960 E	
Benzene	71432									10	1,000								57
Benzo(ghi)perylene	191242				170			3,200	300 M	570 LB	33,000 LB	67			497			670 M	
Benzo[a]pyrene	50328	32.4	31.9	150	370	782	1,450	14,400	700 I	52 L	7,000 L	69	88.8	430	520	763	1,600	1,100 E	
Benzo[b]fluoranthene	205992											130			1,107			1,800 E I	
Benzo[k]fluoranthene	207089	27.2			240			13,400	13,400B	380 LB	38,000 LB	70			537			1,800 E I	
Benzoic acid	65850																	65 O	
Benzyl alcohol	100516																	52 B	
BHC, alpha (α-HCH)	319846				6			100		3	< 2,000								
BHC, beta (β-HCH)	319857				5			210		9	< 2,000								
BHC, delta (δ-HCH)	319868									< 10	< 2,000								
BHC, gamma- (γ-HCH; Lindane)	58899		0.94	2.37	3	1.38	4.99	10	9 I	0.05	1,200 L		0.32			0.99		> 4.8 N	3.7
Biphenyl	92524											17			73				1,100
Bis(2-ethylhexyl)phthalate (DEHP)	117817								750 †M	< 100	10,000 LB		182			2647		1,300 I	
Bromoform (Tribromomethane)	75252										75,000								650
Butanol	35296721										30,000 S								
Butyl acetate, 1- or 2-	na										200,000 S								
Butyl benzyl phthalate	85687									< 100	48,000 LB							63 M	1,100
Carbaryl	63252									0.03	450 LB								
Carbofuran	1563662									0.02	17 LB								
Carbon tetrachloride (Tetrachloromethane;Tetra)	56235									170 LB	1,000								1,200

4: Entry is lowest, reliable value among AET tests, on 1% TOC basis: I - Infaunal community impact ; M - Microtox bioassay ; H - *Hyalella azteca* bioassay ; † - value on dry weight basis.
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		ARCS *Hyalella* TEL[1]	TEL[2]	TEC[2]	LEL[3]	PEL[2]	PEC[2]	SEL[3]	UET[4] @1%TOC	Target	Intervention	T_{20}[6]	TEL[7]	ERL[7]	T_{50}[6]	PEL[7]	ERM[7]	AET[8]	
Catechol (o-Dihydroxybenzene)	120809									3.2 LB	2,600 LB								
Chlordane	57749		4.5	3.24	7	8.9	17.6	60	30 I	0.03	4,000		2.26	0.5		4.79	6	2.8 A	
Chlordane (alpha)	5103719									< 0.03	< 4,000								
Chlordane (gamma)	5103742									< 0.03	< 4,000								
Chloro, 4- 2-methyl phenol	1570645										< 15,000 S								
Chloro, 4- 2-methylphenoxy acetic acid (MCPA)	94746									0.05	4,000								
Chloro, 4- 3-methyl phenol	59507										< 15,000 S								
Chloro, 4- methyl phenols	na										15,000 S								
Chloroaniline	27134265									5	50,000								
Chlorobenzenes (sum)	na									30	30,000								820
Chloroform (trichloromethane)	67663									20	10,000								
Chloronaphthalene, 1-	90131									57 LB	< 10,000								
Chloronaphthalene, 2-	91587									250 LB	< 10,000								
Chlorophenol, 2-	95578									55 LB	7,800 LB							0.333	
Chlorophenol, 3-	108430									35 L	14,000 L								
Chlorophenol, 4-	106489									20 LB	1,400 LB								
Chlorophenols (sum)	na									10	10,000								
Chrysene	218019	26.83	57.1	166	340	862	1,290	4,600	800 I	8,100 LB	35,000 LB	82	108	384	650	846	2,800	950 E	
Cresol [m-] (3-Methyl phenol)	108394									1,600 L	16,000 L								
Cresol [o-] (2-Methyl phenol)	95487									500 L	50,000 L							8 B	
Cresol [p-] (4-Methyl phenol)	106445									5.1 LB	2,600 LB							100 B	
Cresols, sum	1319773									50	5,000								
Cyclohexanone	108941									100	45,000								
DDD, 4,4- (p,p-DDD, TDE)	72548		3.54	4.88	8	8.51	28	60	< 60 I	3.9 LB	34,000 LB		1.22	2		7.81	20	< 16 I	
DDE, 4,4- (p,p-DDE)	72559		1.42	3.16	5	6.75	31.3	190	<50 I	5.8 LB	1,300 LB		2.07	2.2		374	27	< 9 I	
DDT, 4,4- (p,p-DDT)	50293		1.19 c	4.16	8	4.77 c	62.9	710	50 I	9.8 LB	1,000 L		1.19	1		4.77	7	< 12 E	
DDT+DDE+DDD (sum)	na		7	5.28	7	4,450	572	120	50 I	10	4,000		3.89	1.58		51.7	46.1	11 B	
Diazinon	333415																		1.9
Dibenz[ah]anthracene	53703	10	6.22 c	33	60	135 c		1,300	100 M			19	6.22	63.4	113	135	260	230 OM	
Dibenzofuran	132649								5,100 H									110 E	2,000

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		ARCS *Hyalella* TEL[1]	TEL[2]	TEC[2]	LEL[3]	PEL[2]	PEC[2]	SEL[3]	UET[4] @1%TOC	Target	Intervention	T_{20}[6]	TEL[7]	ERL[7]	T_{50}[6]	PEL[7]	ERM[7]	AET[8]	
Dichloroaniline, 2,4-	554007									< 5	< 50,000 S								
Dichloroaniline, 3,4-	95761									< 5	< 50,000 S								
Dichloroaniline, 3,4-	95761									< 5	< 50,000 S								
Dichlorobenzene, 1,2-	95501									< 30	17,000 LB							13 N	340
Dichlorobenzene, 1,3-	541731									< 30	24,000 LB								1700
Dichlorobenzene, 1,4-	106467									< 30	18,000 LB							110 IM	350
Dichlorobenzenes	25321226									< 30	19,000 LB								
Dichloroethane, 1,1-	75343									20	15,000								
Dichloroethane, 1,2-	107062									20	4,000								
Dichloroethene, 1,1- (vinylidene chloride)	75354									100	300								
Dichloroethene, 1,2- (cis or trans)	540590									200	1,000								
Dichlorophenol, 2,4-	120832									< 10	8,400 LB							0.2083	
Dichlorophenol, 2,6-	87650									< 10	57,000 LB								
Dichlorophenol, 3,4-	95772									< 10	57,000 LB								
Dichlorophenol, 3,5-	591355									< 10	5,400 LB								
Dichlorophenols (sum)	na									< 10	22,000 LB								
Dichloropropane, 1,2- (propylene dichloride)	78875									< 2	< 2,000								
Dieldrin ‡	60571		2.85	1.9	2	6.67	61.8	910	300 I	0.5	1,900 LB	0.83	0.72	0.02	2.9	4.3	8	1.9 E	
Diethyl phthalate	84662									530 L	53,000 L							6 BL	630
Diethylene-glycol	111466										270,000 S								
Dihydroxybenzenes, sum	na									62 LB	8,000 LB								
Di-iso-butyl phthalate	84695									92 LB	17,000 LB								
Dimethyl phthalate	131113									1,000 LB	84,000 LB							6 B	
Dimethylnaphthalene, 2,6-	581420											25			133				
Dimethylphenol, 2,4-	105679																	18 N	
Di-n-butyl phthalate	84742								110 H	7,000 LB	36,000 LB							58 BL	11,000
Di-n-octyl phthalate	117840									< 100	< 60,000							61 BL	
Dodecylbenzene	25155300										1,000,000 S								
Endosulfan (a or b)	115297									0.01	4,000								2.9 α 14 β

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Endosulfan II	33213659																		
Endrin	72208		2.67	2.22	3	62.4	207	1,300	500 I	0.04	95 L								
Ethyl acetate	141786										75,000 S								
Ethyl acetate	141786										75,000 S								
Ethyl benzene	100414									30	50,000							4 EL	3,600
Ethylene glycol	107211										100,000 S								
Fluoranthene	206440	31.46	111	423	750	2,355	2,230	10,200	1,500 M	1,000 LB	260,000	119	113	600	1,034	1,494	5,100	1,300 E	
Fluorene	86737	10	21.2 c	77.4	190	144 c	536	1,600	300 M			19	21.2	19	114	144	540	120 E	540
Formaldehyde	50000										100 S								
Guthion (Azinphos-methyl)	865000									0.005	2,000 S								
Heptachlor	76448								10 I	0.7	4,000							0.3 B	
Heptachlorepoxide	1024573		0.6	2.47	5	2.74	16	50	30 I	0.0002	4,000	0.6 c				2.74 c			
Hexachlorobenzene	118741				20			240	100 I	1.4 LB	2,000 LB							6 B	
Hexachlorobutadiene (HCBD)	87683																	1.3 E	
Hexachlorocyclohexane (BHC)	608731				3			120	100 I										
Hexachloroethane	67721																	73 BL	1,000
Hydroquinone (p-dihydroxybenzene)	123319									50	43,000 LB								
Indeno[1,2,3-cd]pyrene	193395	17.32			200			3,200	330 M	31 LB	1,900 LB	68			488			600 M	
Linar alkylbenzene sulfonates (LAS)	na												<12,800 €			>62,000 €			
Malathion	121755																		0.67
Maneb	12427382									2	22,000 L								
Methanol	67561										30,000 S								
Methoxychlor	72435																		19
Methyl ethyl ketone (MEK; 2-Butanone)	78933										35,000 S								
Methyl naphthalene, 2-	91576											21	20.2	70	128	201	670	64 E	
Methylene chloride (Dichloromethane, DCM)	75092									18 LB	3,900 L								
Methylnaphthalene, 1-	90120											21			94				
Methylphenanthrene, 1-	832699											18			112				
Methyl-tert-butyl ether (MTBE)	1634044										100,000 S								
Mirex	2385855				7			1,300	800 I										

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Monochloroaniline (3 isomers)	na									5	50,000								
Monochlorobenzenes	108907									< 30	15,000 LB								820
Monochloronaphthalenes	na									120 LB	10,000								
Monochlorophenols (sum)	na									< 10	5,400 L								
Naphthalene	91203	14.65	34.6 c	176		391 c	561		600 I	120 LB	17,000 LB	30	34.6	160	217	391	2,100	230 E	480
Nitrobenzene	98953																	21 N	
Nitrosodiphenylamine, N-	86306																	28 I	
Nonylphenol	25154523		1,400 c										1,000 c						
PAHs, Low MW	na	76.42							5,300 M	< 1,000	< 40,000		312	552		1,442	3,160	1,200 E	
PAHs, High MW	na	193							6,500 M	< 1,000	< 40,000		655	1,700		6,676	9,600	7,900 E	
PAHs, Total	na	264.1		1,610	4,000		22,800*	100,000*	12,000 M	1,000	40,000		1,684	4,022		16,770	44,792		
PCB 105	32598144									1.5 LB	< 1,000								
PCB 126	57465288									0.0025 LB	920 LB								
PCB 77	32598131									0.42 LB	< 1,00								
PCB-Aroclor 1254	na		60 c		60	340 c		340					63.3 c			709 c			
PCBs (sum)	1336363	31.62	34.1	59.8	70	277	676	5,300	26 M	0.3 LB	1,000	35	21.6	22.7	368	189	180	130 M	
Pentachloroaniline	527208										10,000 S								
Pentachlorobenzene	608935									15 LB	16,000 LB								690
Pentachlorophenol [PCP: at ph 7.8‡]	87865									< 10	8,000 LB							17 B	
Perylene	198550											74			453				
Phenanthrene	85018	18.73	41.9	204	560	515	1,170	9,500	800 I	3,300 LB	31,00 LB	68	86.7	240	455	544	1500	660 E	
Phenol	108952								48 † H	50	14,000 LB							130 E	
Phthalates (sum)	na									100	60,000								
Propanol, 2- (Isopropanol)	67630										220,000 S								
Pyrene	129000	44.27	53	195	490	875	1,520	8,500	1,000 i			125	153	665	932	1,398	2,600	2,400 E	
Pyridine	110861									100	500								
Resorcinol (m-dihydroxybenzene)	108463									34 LB	4,600 LB								
Styrene (Vinyl benzene)	100425									200 LB	86,000 LB								
Tetrachloroaniline, 2,3,5,6-	3481207										< 30,000 S								
Tetrachlorobenzene, 1,2,3,4-	634662									160 L	16,000 L								
Tetrachlorobenzene, 1,2,3,5-	634902									6.5 L	650 L								

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Tetrachlorobenzene, 1,2,4,5-	95943									10 L	1,000 L								
Tetrachlorobenzenes	na									22 L	2,200 L								
Tetrachloroethylene (Tetrachloroethene; PCE; PER)	127184									2	4,000							57 I	530
Tetrachlorophenol, 2,3,4,5-	4901513									< 10	< 10,000								
Tetrachlorophenol, 2,3,4,6-	58902									< 10	< 10,000								
Tetrachlorophenols (sum)	25167833									< 10	< 10,000								
Tetrahydrofuran	109999									100	2,000								
Tetrahydrothiophene	110010									100	8,800 LB								
Toluene	108883									10	47,000 L								670
Toxaphene	8001352		0.1 c										0.1 c						28
Tributyltinoxide	56359									< 10	< 2,500								
Trichloroaniline (multiple isomers)	na										10,000 S								
Trichloroaniline, 2,4,5-	636306										< 10,000 S								
Trichlorobenzene, 1,2,3-	87616									< 11 L	5,000 L								
Trichlorobenzene, 1,2,4-	120821									11 LB	5,100 LB							> 4.8 E	9,200
Trichlorobenzenes	12002481									38 L	11,000 L								
Trichloroethane, 1,1,1-	71556									70	15,000								170
Trichloroethane, 1,1,2-	79005									400	10,000								
Trichloroethene (TCE)	na									7.8 L	2,500 L							41 N	1,600
Trichlorophenol, 2,3,5-	na									< 10	4,500 L								
Trichlorophenol, 2,4,5-	95954									< 10	22,000 LB							3 I	
Trichlorophenol, 2,4,6-	88062									< 10	110,000 LB							6 I	
Triclorophenols, (sum)	na									< 10	22,000 L								
Vinyl chloride	75014									10	100								
Xylene	1330207									130 LB	17,000 LB							4 BL	
Xylene, m-	108383									110 LB	18,000 LB								25
Xylene, o-	95476									89 LB	9,300LB								

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Sources

1 – Assessment & Remediation of Contaminated Sediments (ARCS) Program, Sept 1996. EPA 905-R96-008.

2 – MacDonald et al, 2000. Arch ET&C 39(1):20-
C – Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Tables Update 2002, www.ccme.ca/publications/cegg_rcqe.html

3 – Persuad 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Thompson et al., 2005. Enval Monitor & Assessment 110:71-

4 – Buchman 1999. NOAA HAZMAT Report 99-1.

5 – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has not been done here.
Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel, 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water: updated proposal for first series of compounds. Nat. Inst. Public Health and the Env., and subsequent updates as published elsewhere.
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6 – Field et al., 2002. ET&C 21:1993-

7 – MacDonald et al., 1996. Ecotox. 5(4):253-
C – Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Tables Update 2002, www.ccme.ca/publications/cegg_rcqe.html
€ - DelValls et al., 1999. Ecotox. & Env Rest 2(1):34-

8 – Wash Dept Ecol Publ 95-308, 1995 and 97-323a, 1997
Gries & Waldrow Puget Sound Dredged Disposal Analysis Rept 1996. http://www.ecy.wa.gov/biblio/wac173204.html
plus unpublished information.

9 – EcoUpdate EcoTox Thresholds, http://www.epa.gov/oswer/riskassessment/

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Screening Quick Reference Tables for Organic in Water and Soil

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		Dutch [1]		MCL [2]	Fresh		Marine		Invertebrates[4]	Mammals [5]	Plants [6]	Other [7]
		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
2,3,7,8-TCDD (dioxin TEQs)	1746016		0.001 ng/L S	0.00003	<0.01 *	<0.00001 *				0.000199		
2,4,5-Trichlorphenoxyacetic acid (2,4,5-T)	93765			9 W		36 NZ				596		
2,4-Dichlorophenoxyacetic acid (2,4-D)	94757			70		4.0 CA				27.2		
Acenaphthene	83329				1,700 *	5.8 CA	970 *	40 Eco		682,000	20,000	
Acenaphthylene	208968					4,840 V	300 *C			682,000		
Acetone	67641				28,000 T	1,500 T				2,500		
Acetonitrile	75058					160 NZ				1,370		
Acetophenone	98862									300,000		
Acetylaminofluorene, 2-	53963									596		
Acridine	260946					4.4 CA						
Acrolein	107028				68 *	0.01 NZ	55 *	0.1 NZ		5,270		
Acrylonitrile	107131	0.08	5 S		7,550 *	2,600 *				23.9		1,000,000 M 0.007 D
Alcohol ethoxylated surfactants (AE)	na					140 NZ						
Alcohol ethoxyolated sulfate (AES)	na					650 NZ						
Aldicarb	116063			9 C		1 CA		0.15 CA				
Aldrin	309002	0.009 ng/L	< 0.1		1.5 (½)	0.017 V	0.65 (½)				3.32 V	0.06 D
Aldrin+Dieldrin+Endrin	na		0.1	<0.03 W								5 D
Allyl chloride	107051									13.4		
Aminobiphenyl, 4-	92671									3.05		
Aminomethylphosphonic acid (AMPA)	1066519	0.797 L										
Amitrole	61825					22 NZ						
Aniline	62533					2.2 CA				56.8		
Anthracene	120127	0.0007	5		13 T	0.73 T 0.012 CA	300 *C			1.48E6		
Aramite	140578									16,600		
Atrazine	1912249	29 ng/L	76 L	3		1.8 CA		10 BC				0.2 D
Benz[a]anthracene	56553	0.0001	0.5		0.49 T	0.027 T	300 *C			5,210		
Benzene	71432	0.2	30	5	2,300 T	46 Eco	5,100 *	110 CA		255		10 D
Benzidine	92875				70 T	3.9 T						
Benzo(ghi)perylene	191242	0.0003	0.05			7.64 V	300 *C			119,000		
Benzo[a]pyrene	50328	0.0005	0.05	0.2	0.24 T	0.014 T Eco	300 *C			1,520		

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Benzo[b]fluoranthene	205992					9.07 V	300 *C			59,800		
Benzo[k]fluoranthene	207089	0.0004	0.05				300 *C			148,000		
Benzoic acid	65850				740 T	42 T						
Benzyl alcohol	100516				150 T	8.6 T				65,800		
BHC, alpha (α-HCH)	319846	33 ng/L	<1		39 T	2.2 T				99.4		3 D
BHC, beta (β-HCH)	319857	8 ng/L	<1		39 T	2.2 T 0.495 V					3.98 V	9 D
BHC, delta δ-HCH)	319868	< 0.05	<1		39 T	2.2 T				9,940		< 10 D
BHC, gamma- (γ-HCH; Lindane)	58899	9 ng/L	<1	0.2	0.95	0.08	0.08 (½)				5 V	0.05 D
BHC (sum)	na	0.05	1		< 0.95	< 0.08	< 0.08					10 D
Biphenyl	92524					14 T Eco					60,000	
Bis(2-chloroethoxy) methane	111911				11,000 *C		12,000 *C	6,400 *C		302		
Bis(2-chloroethyl) ether	111444					1,900 V				23,700		
Bis(2-ethylhexyl)phthalate (DEHP)	117817	1.9 ng/L L	< 5	6	400 p	32 Eco 16 CA 0.3 V	400 p	360 p		925		< 100 D
Bis-2-chloro-1-methylethylether	108601									19,900		
Bromocil	314409					5 CA						
Bromodichloromethane (Dichlorobromomethane)	75274			60 W	11,000 *C		12,000 *C	6,400 *C		540		
Bromoform (Tribromomethane)	75252		630		2,300 T	320 T Eco				15,900		
Bromoxynil	1689845			5 C		5 CA						
Butanol	35296721		5,600 S									
Butyl acetate, 1- or 2-	na		6,300 S									
Butyl benzyl phthalate	85687	2.9 ng/L L	< 5		940 *C	19 T Eco	2,944 *C	3.4 *C		239		< 100 D
Captan	133062					1.3 CA						
Carbaryl	63252	2 ng/L	41 L	90 C		0.2 CA		0.32 CA				
Carbofuran	1563662	9 ng/L	6.5 L	40		1.8 CA		0.06 NZ				
Carbon disulfide	75150				17 T	0.92 T				94.1		
Carbon tetrachloride (Tetrachloromethane;Tetra)	56235	0.01	10	5	180 T	9.8 T	50,000 *	5,000 x 0.1		2,980		1,000,000 M 400 D
Catechol (o-Dihydroxybenzene)	120809	0.2	630 L									50 D

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Chlordane	57749	0.02 ng/L	0.2	2	1.2 (½)	0.00215 (½)	0.045 (½)	0.002 (½)			224 v	0.03 D
Chlordane (alpha)	5103719	< 0.02 ng/L	< 0.2								< 224 v	< 0.03 D
Chlordane (gamma)	5103742	< 0.02 ng/L	< 0.2								< 224 v	< 0.03 D
Chlorfenvinphos	470906					0.1 EU		0.1 EU				
Chloroacetamide	79072								2,000			5 D
Chloroaniline	27134265		30									< 5 D
Chloroaniline, 3-	108429		< 30						30,000		20,000	< 5 D
Chloroaniline, 4-	106478		< 30		250 *C	50 *C	160 *C	129 *C		1,100		< 30 D
Chlorobenzenes (sum)	na	< 7	< 180	100		130 Eco <47 V			< 40,000	< 13,100		30 D
Chlorobenzilate	510156									5,050		20 D
Chloroform (trichloromethane)	67663	6	400	200 W	490 T	1.8 CA				1,190		
Chloro, 4- 2-methyl phenol	1570645		< 350 S									
Chloro, 4- 3-methyl phenol	59507		< 350 S							7,950		
Chloro, 4- methyl phenols	na		350 S							< 7,950		
Chloro, 4- 2-methylphenoxy acetic acid (MCPA)	94746	0.02	50	2 W		2.6 CA		4.2 CA				0.05 D
Chloronaphthalene, 1-	90131	3.7 ng/L L	< 6									
Chloronaphthalene, 2-	91587	0.016 L	< 6		1,600 * C	0.396 V	7.5 * C			12.2		
Chlorophenol, 2-	95578	< 0.3	< 100		4,380 *	490 NZ 24 V				243		< 10 D
Chlorophenol, 3-	108430	< 0.3	< 100						10,000		7,000	< 10 D
Chlorophenol, 4-	106489	< 0.3	< 100			220 NZ						< 10 D
Chlorophenols (sum)	na	0.3	100			< 24 V			< 10,000	< 243	< 7,000	< 10 D
Chloroprene	126998									2.9		
Chlorothalonil	1897456			200 BC		0.18 CA		0.36 CA				
Chlorpyrifos	2921882			30 W	0.083	0.041	0.011	0.0056				
Chrysene	218019	0.003	0.2				300 *C			4,730		
Cresol [m-] (3-Methyl phenol)	108394	< 0.2	< 200							3,490		< 50 D
Cresol [o-] (2-Methyl phenol)	95487	< 0.2	<200		230 T	13 T				40,400		< 50 D
Cresol [p-] (4-Methyl phenol)	106445	< 0.2	< 200							163,000		< 50 D
Cresols, sum	1319773	0.2	200		< 230 T	< 13 T				< 3,490		50 D
Cyclohexanone	108941	0.5	15,000									100 D

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DDD, 4,4- (p,p-DDD, TDE)	72548	<0.004 ng/L	< 0.01	< 1 W	0.19 T	0.011 T	3.6 *	0.36 x 0.1		758		< 10 D
DDE, 4,4- (p,p-DDE)	72559	<0.004 ng/L	< 0.01	< 1 W	1,050 *	105 x 0.1	14 *	1.4 x 0.1		596		< 10 D
DDT, 4,4- (p,p-DDT)	50293	<0.004 ng/L	< 0.01	< 1 W	0.55 (½)	0.0005 (½)	0.065 (½)	0.0005 (½)		3.5		< 10 D
DDT+DDE+DDD (sum)	na	0.004 ng/L	0.01	1 W	<0.55 (½)	<0.0005 (½)	<0.065 (½)	<0.0005 (½)		21 EPA		93 A 10 D
Decane	124185				880 T	49 T						
Deltamethrin	52918635					0.0004 CA						
Demeton	8065483					0.1		0.1				
Diallate	2303164									452		
Diazinon	333415			20 C	0.17	0.17	0.82	0.82				
Dibenz[ah]anthracene	53703						300 *C			18,400		
Dibenzofuran	132649				66 T	3.7 T						
Dibromo, 1,2- 3-chloropropane (DBCP)	96128			0.2						35.2		
Dibromochloromethane (Chlorodibromomethane)	124481			100 W	11,000 *C		12,000 *C	6,400 *C		2,050		
Dibromoethane, 1,2-	106934			0.4 W						1,230		
Dicambia	1918009			120 C		10 CA						
Dichloro, 1,4- 2-butene (cis)	1476115											1,000,000 M
Dichloro, 1,4- 2-butene (trans)	110576											1,000,000 M
Dichloroaniline, 2,4-	554007		< 100 S			7 NZ			100,000			< 5 D
Dichloroaniline, 3,4-	95761		< 100 S			3 NZ		150 NZ	20,000			< 5 D
Dichlorobenzene, 1,2-	95501	< 3	< 50	600	260 T	0.7 CA	< 1,970 *S	42 CA		2,960		< 30 D
Dichlorobenzene, 1,3-	541731	< 3	< 50		630 T	71 T Eco 38 V	< 1,970 *S			37,700		< 30 D
Dichlorobenzene, 1,4-	106467	< 3	< 50	75	180 T	15 T Eco 60 NZ 9.4 V	< 1,970 *S	129 *C	20,000	546		< 30 D
Dichlorobenzenes	25321226	3	50	< 75	< 180 T	< 0.7 CA	1,970 *S		< 20,000	< 548		< 30 D
Dichlorobenzidine, 3,3-	91941					4.5 V				646		
Dichlorodifluoromethane	75718									39,500		
Dichloroethane, 1,1-	75343	7	900		830 T	47 T Eco				20,100		20 D
Dichloroethane, 1,2-	107062	7	400	5	8,800 T	100 CA	113,000 *	11,300 x 0.1		21,200		20 D

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Dichloroethene, 1,1- (vinylidene chloride)	75354	0.01	10	7	450 T	25 T	224,000 *S			8,280		100 D
Dichloroethene, 1,2- (cis or trans)	540590	0.01	20	70 cis	1,100 T	590 T	224,000 *S					200 D
Dichloroethene, 1,2- (trans)	156605			100	11,600 *S	1,160 x 0.1	224,000 *S			784		
Dichlorophenol, 2,4-	120832	< 0.2	< 30	900 C	2,020 *	160 NZ 11 V				87,500		< 10 D
Dichlorophenol, 2,6-	87650	< 0.2	< 30			< 0.2 CA				1,170		< 10 D
Dichlorophenol, 3,4-	95772	< 0.2	< 30			< 0.2 CA			20,000		20,000	< 10 D
Dichlorophenol, 3,5-	591355	< 0.2	< 30			< 0.2 CA						< 10 D
Dichlorophenols (sum)	na	0.2	30	< 900 C	<2,020 *	0.2 CA			< 20,000	< 1,170	< 20,000	< 10 D
Dichloropropane, 1,2- (propylene dichloride)	78875	< 0.08	< 80	5	23,000 *S	5,700 *S	10,300 *S	3,040 *S	700,000	32,700		< 2 D
Dichloropropene, 1,3-	542756			20 W	0.99 T	0.055 T	790 *S					
Dichloropropene, 1,3- (cis)	10061015			< 20 W	< 0.99 T	< 0.055 T				398		
Dichloropropene, 1,3- (trans)	10061026			< 20 W	< 0.99 T	< 0.055 T				398		
Diclofop-methyl	51338273			9 C		6.1 CA						
Dicofol	115322					0.5 NZ		0.1 NZ				
Didecyl dimethyl ammonium chloride (DDAC)	7173515					1.5 CA						
Dieldrin ‡	60571	0.1 ng/L	< 0.1		0.24	0.056	0.355 (½)	0.00095 (½)		2.38		22 A
Diethyl phthalate	84662	< 0.5	< 5		1,800 T	210 T 110 V	2,944 *C	3.4 *C		24,800	100,000	< 100 D
Diethylene-glycol	111466		13,000 S									
Dihydroxybenzenes, sum	na	0.24 L										
Di-iso-butyl phthalate	84695	< 0.5	< 5									< 100 D
Dimethoate	60515			6 W		6.2 CA 0.15 NZ				218		
Dimethyl aminoazobenzene [p-]	60117									40		
Dimethyl benz(a)anthracene, 7,12-	57976									16,300		
Dimethyl benzidine, 3,3-	119937									104		
Dimethyl naphthalene, 2,6-	581420											
Dimethyl phenethylamine [alpha,alpha]	122098									300		
Dimethyl phenol, 2,4-	105679				2,120 *	100 V					10 V	
Dimethyl phthalate	131113	< 0.5	< 5		940 *C	3 *C	2,944 *C	3.4 *C	200,000	734,000		< 100 D

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Di-n-butyl phthalate	84742	< 0.5	< 5		190 T	19 CA 9.7 V	2,944 *C	3.4 *C		150	200,000	< 100 D
Dinitrobenzene, 1,3-	99650									655		
Dinitrophenol, 2,4-	51285				230 *C	45 NZ 19 V	4,850 *C			60.9		
Dinitrotoluene, 2,4-	121142				330 *	65 NZ 44 V	590 * S	370 *S		1,280		
Dinitrotoluene, 2,6-	606202									32.8		
Di-n-octyl phthalate	117840	< 0.5	< 5		940 *C	3 *C	2,944 *C	3.4 *C		709,000		< 100 D
Dinoseb	88857			7		0.05 CA				21.8		
Dioxane, 1,4-	123911									2,050		
Dioxins (sum of PCDDs)	na		0.001 ng/L S							0.000199		
Diphenlyhydrazine 1,2-	122667				270 *	27 x 0.1						
Diphenylamine	122394									1,010		
Diquat	85007			20		1.4 NZ						
Disulfoton	298044									19.9		
Diuron	330541			150 C		0.1EU		0.1EU				
Dodecylbenzene	25155300		0.02 S									
Endosulfan (α or β: I or II)	115297	0.2 ng/L	5		0.11 (½)	0.028 (½)	0.017 (½)	0.00435 (½)		119		0.01 D
Endosulfan sulfate	1031078					2.22 V				35.8		
Endrin	72208	0.04 ng/L	< 0.1	2	0.086	0.036	0.0185 (½)	0.00115 (½)		10.1		0.04 D
Endrin aldehyde	7421934					0.15 V				10.5		
Esfenvalerate	66230044					0.001 NZ						
Ethanol	64175					1,400 NZ						
Ethyl acetate	141786		15,000 S									
Ethyl benzene	100414	4	150	700	130 T	7.3 T 14 V	430 *	25 CA		5,160		30 D
Ethyl methacrylate	97632									30,000		
Ethylene glycol	107211		5,500 S			192,000 CA						
Famphur	52857									49.7		
Fenitrothion	122145					0.2 NZ						
Fluoranthene	206440	0.003	1		3,980 *	0.04 CA	40 *	11 Eco		122,000		
Fluorene	86737				70 T	3.9 T Eco	300 *C		30,000	122,000		

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Formaldehyde	50000		50 S	900 W								
Furan	110009										600,000	
Glyphosate	1071836			280 C		65 CA						
Guthion (azinphos-methyl)	865000	0.1 ng/L	2 S	20 C		0.01 0.02 NZ		0.01				0.005 D
Heptachlor	76448	0.005 ng/L	0.3	0.4	0.26 (½)	0.0019 (½)	0.0265 (½)	0.0018 (½)		5.98		0.7 D
Heptachlor epoxide	1024573	0.005 ng/L	3	0.2	0.26 (½)	0.0019 (½)	0.0265 (½)	0.0018 (½)		152		0.0002 D
Hexachlorobenzene	118741	2.1E-7 L	0.5	1	6 p	3.68 p 0.0003 V	160 *C	129 *C		199		1,000,000 M
Hexachlorobutadiene (HCBD)	87683			0.6 W	90 *	1.3 CA 0.053 V	32 *	3.2 x 0.1		39.8		
Hexachlorocyclohexane (BHC)	608731				100 *	10 x 0.1	0.34 *	0.034 x 0.1				
Hexachlorocyclopentadiene	77474			50	7 *	5.2 *	7 *	0.7 x 0.1		755	10,000	
Hexachloroethane	67721				210 T	12 T Eco 8 V	940 *	94 x 0.1		596		
Hexachlorophene	70304									199		
Hexane	110543				10 T	0.58 T						
Hexanone, 2- (methyl butyl ketone)	591786				1,800 T	99 T				12,600		
Hydroquinone (p-dihydroxybenzene)	123319	0.2	800									50 D
Indeno[1,2,3-cd]pyrene	193395	0.0004	0.05			4.31 V	300 *C			109,000		
Iodo, 3- 2-propynl butyl carbamate (IPBC)	55406536					1.9 CA						
Isodrin	465736										3.32 V	
Isophorone	78591				117,000 *	1,170 x 0.1 920 V	12,900 *	1,290 x 0.1		139,000		
Isoproturon	34123596			9 W		0.1 EU		0.1 EU				
Isosafrole	120581									9,940		
Kepone	143500									32.7		
Linar alkylbenzene sulfonates (LAS)	na					280 NZ						
Linuron	335502					7.0 CA						
Malathion	121755			190 C		0.1		0.1				
Maneb	12427382	0.05 ng/L	0.1									2 D
Methacrylonitrile	126987									57		
Methanol	67561		24,000 S									

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Methanol	67561		24,000 S									
Methapyrilene	91805									2,780		
Methomyl	16752775					3.5 NZ						
Methoxychlor	72435			40		0.03		0.03		19.9		
Methyl bromide	74839					16 V				235		
Methyl chloride	74873									10,400		
Methyl cholanthrene, 3-	56495									77.9		
Methyl, 2- 4,6-dinitrophenol	534521									144		
Methyl ethyl ketone (MEK; 2-Butanone)	78933		6,000 S		240,000 T	14,000 T				89,600		
Methyl iodide	74884									1,230		
Methyl methacrylate	80626									984,000		
Methyl methanesulfanate	66273									315		
Methyl naphthalene, 1-	90120				37 T	2.1 T						
Methyl naphthalene, 2-	91576					330 V	300 *C			3,240		
Methyl parathion	298000									0.292		
Methyl, 4- 2-pentanone	108101				2,200 T	170 T				443,000		
Methyl-tert-butyl ether (MTBE)	1634044		9,200 S			10,000 CA		5,000 CA				
Methylene bromide (Dibromomethane)	74953				11,000 *C		12,000 *C	6,400 *C		65,000		
Methylene chloride (Dichloromethane, DCM)	75092	0.01	1,000	5	26,000 T	2,200 T 98.1 CA	12,000 *C	6,400 *C		4,050		400 D
Metolachlor	51218452			10 W		7.8 CA						
Metribuzin	21087649			80 C		1 CA						
Mineral oil (Operationally defined)	8012951	50	600									50,000 D
Mirex	2385855					0.001		0.001				
Molinate	2212671			6 W		3.4 NZ						
Monochloroaniline (3 isomers)	na		30									5 D
Monochlorobenzenes	108907	7	180	100	1,100 T	1.3 CA	160 *C	25 CA	40,000	13,100		< 30 D
Monochloronaphthalenes		7.7 ng/L L	6									120 L
Monochlorophenols (sum)	na	0.3	100			7 CA						< 10 D
Naphthalene	91203	0.01	70		190 T	1.1 CA	2,350 *	1.4 CA		99.4		
Naphthoquinone, 1,4-	130154									1,670		

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Naphthylamine, 1-	134327									9,340		
Naphthylamine, 2-	91598									3,030		
Nitroaniline [m-]	99092									3,160		
Nitroaniline [p-]	100016									21,900		
Nitroaniline, 2-	88744									74,100		
Nitrobenzene	98953				27,000 *	550 NZ 220 V	6,680 *	668 x 0.1	40,000	1,310		1,000,000 M
Nitro-o-toluidine, 5-	99558									8,730		
Nitrophenol, 2-	88755									1,600		
Nitrophenol, 4-	100027				1,200 T	300 T 60 V	4,850 *C		7,000	5,120		
Nitroquinoline, 4- 1-oxide	56575									122		
Nitrosodiethylamine, N-	55185					768 V				69.3		
Nitrosodimethylamine, N-	62759									0.0321		
Nitroso-di-n-butylamine, N-	924163									267		
Nitroso-di-n-propylamine, N-	621647									544		
Nitrosodiphenylamine, N-	86306				3,800 T	210 T	3,300,000*C		20,000	545		
Nitrosomethylethylamine, N-	10595956									1.66		
Nitrosomorpholine, N-	59892									70.6		
Nitrosopiperidine, N-	100754									6.65		
Nitrosopyrrolidine, N-	930552									12.6		
Nonylphenol	25154523				28	6.6	7	1.7				
o,o-diethyl o-2-pyrazinylphosphorothioate	297972									799,000		
Octanone, 2-	111137				150 T	8.3 T						
PAHs, High MW	na						300 *C		29,000 EPA	100,000 EPA		< 1,000 D
PAHs, Low MW	na						300 *C		18,000 EPA	1,100 EPA		< 1,000 D
PAHs, Total	na						300 *C					1,000 D
Paraquat	4685147					0.5 NZ						
Parathion	56382			50 C	0.065	0.013			0.34 V			
PCBs (sum)	1336363	0.01	0.01	0.5	0.6 T 0.03 NZ	0.014	0.033 T	0.03		0.332	40,000	< 20 D
Pentachloroaniline	527208		1 S						100,000			

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Pentachlorobenzene	608935	0.003	1		8.4 T	0.47 T 0.019 V	160 *C	129 *C	20,000	497		< 30 D
Pentachloroethane	76017				7,240 *	1,100 *	390 *	281 *		10,700		
Pentachloronitrobenzene	82688									7,090		
Pentachlorophenol [PCP: at pH 7.8]	87865	0.04	3	1.0	19 ph	15 Ph	13	7.9	6,000	119	3,000	2,100 A
Pentanol, 1-	71410				2,000 T	110 T						
Permethrin	52645531					0.004 CA		0.001 CA				
Phenacetin	62442									11,700		
Phenanthrene	85018	0.003	5		30 p	6.3 p Eco 3.6 V	7.7 p	4.6 p		45,700		
Phenol	108952	0.2	2,000		10,200 *	320 NZ 180 V	5,800 *	400 NZ	30,000	120,000	70,000	1,000,000 M 500 D
Phenylenediamine [p-]	106503									6,160		
Phorate	298022			2 C						0.496		
Phthalates (sum)	na	0.5	5									100 D
Picloram	1918021			500		29 CA						
Picoline, 2-	109068									9,900		
Polychlorinated dibenzofurans	51207319									0.0386		
Pronamide	23950585										13.6 v	
Propanol, 2- (Isopropanol)	67630		31,000 S		130 T	7.5 T						
Propionitrile	107120									49.8		
Propylene glycol	57556					500,000 CA						
Pyrene	129000					0.025 CA	300 *C			78,500		
Pyridine	110861	0.5	30							1,030		100 D
Quinoline	91225					3.4 CA						
Resorcinol (m-dihydroxybenzene)	108463	0.2	600									50 D
Safrole	94597									404		
Silvex (2,4,5-TP)	93721			50							109 v	
Simazine	122349			4		10 CA 3.2 NZ		1 EU				
Styrene (Vinyl benzene)	100425	6	300	100		72 CA 32 V				4,690	300,000	300 D

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Tebuthiuron	34014181			490 BC		1.6 CA 2.2 NZ						
Temephos	3383968					0.05 NZ		0.05 NZ				
Tetrachloroaniline, 2,3,5,6-	3481207		< 10 S						20,000		20,000	
Tetrachlorobenzene, 1,2,3,4-	634662	< 0.01	< 2.5		250 *C	1.8 CA	160 *C	129 *C	10,000			< 30 D
Tetrachlorobenzene, 1,2,3,5-	634902	< 0.01	< 2.5		250 *C		160 *C	129 *C				< 30 D
Tetrachlorobenzene, 1,2,4,5-	95943	< 0.01	< 2.5		250 *C	50 *C 3 V	160 *C	129 *C		2,020		< 30 D
Tetrachlorobenzenes	na	0.01	2.5		250 *C	< 3 V	160 *C	129 *C	< 10,000	< 2,020		< 30 D
Tetrachloroethane, 1,1,1,2-	630206									225,000		
Tetrachloroethane, 1,1,2,2-	79345				2,100 T	111 CA	9,020 *	902 x 0.1		127		
Tetrachloroethylene (Tetrachloroethene; PCE; PER)	127184	0.01	40	5	830 T	98 T 45 V	10,200 *	450 *		9,920		2 D
Tetrachlorophenol, 2,3,4,5-	4901513	< 0.01	< 10			< 1 CA			20,000			< 10 D
Tetrachlorophenol, 2,3,4,6-	58902	< 0.01	< 10	100 C		20 NZ	440 *	44 x 0.1		199		< 10 D
Tetrachlorophenols (sum)	25167833	0.01	10			1 CA			< 20,000	< 199		< 10 D
Tetraethyldithiopyrophosphate	3689245									596		
Tetrahydrofuran	109999	0.5	300									100 D
Tetrahydrothiophene	110010	0.5	5,000									100 D
Thiobencarb	28249776					2.8 NZ						
Thiram	137268					0.2 NZ		0.01 NZ				
Toluene	108883	7	1,000	1,000	120 T	9.8 T 2 CA	6,300 *	215 CA		5,450	200,000	10 D
Toluidine [o-]	95534									2,970		
Toxaphene	8001352			3	0.73	0.0002	0.21	0.0002		119		
Triallate	2303175					0.24 CA						
Tributyltinoxide	56359	<0.05E-16 ng/L	< 0.7		0.46	0.072	0.42	0.0074				< 1 D
Trichloroaniline (multiple isomers)	na		10 S									
Trichloroaniline, 2,4,5-	636306		< 10 S						20,000		20,000	
Trichlorobenzene, 1,2,3-	87616	< 0.10	< 10			8.0 CA			20,000			< 30 D
Trichlorobenzene, 1,2,4-	120821	< 0.10	< 10	70	700 T	24 CA	160 *C	5.4 CA	20,000	11,100		< 30 D
Trichlorobenzenes	12002481	0.01	10	< 70	< 700 T	< 8 CA	160 *C	<5.4 CA	< 20,000	< 11,100		< 30 D

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		Target	Intervention		Acute [3]	Chronic [3]	Acute [3]	Chronic [3]				
Trichloroethane, 1,1,1-	71556	0.01	300	200	200 T	11 T	31,200 *	3,120 x 0.1		29,800		70 D
Trichloroethane, 1,1,2-	79005	0.01	130	5	5,200 T	1,200 T 500 V		1,900 NZ		28,600		400 D
Trichloroethene (TCE)		24	500	5		21 CA	2,000 *	200 x 0.1		12,400		100 D
Trichloroethene, 1,1,1-	71556	< 24	< 500	< 5	< 440 T	< 21 CA						< 100 D
Trichloroethene, 1,1,2-	79016	< 24	< 500	< 5	< 440 T	< 21 CA						< 100 D
Trichlorofluoromethane	75694				11,000 *C		12,000 *C	6,400 *C		16,400		
Trichlorophenol, 2,3,5-		< 0.03	< 10			< 18 CA						< 10 D
Trichlorophenol, 2,4,5-	95954	< 0.03	< 10		100 p	63 p	240 p	11 p	9,000	14,100	4,000	< 10 D
Trichlorophenol, 2,4,6-	88062	< 0.03	< 10	5 C		20 NZ 4.9 V			10,000	9,940		< 10 D
Triclorophenols, (sum)	na	0.03	10			18 CA			< 9,000	<9,940	< 4,000	< 10 D
Trichloropropane, 1,2,3-	96184									3,360		
Triethylphosphorothioate [O,O,O-]	126681									818		
Trifluralin	1582098			20 W		0.2 CA		0.1EU				
Trinitrobenzene, 1,3,5-	99354									376		
Trinitrotoluene, 2,4,6-	118967					140 NZ						
Vinyl acetate	108054				280 T	16 T				12,700		
Vinyl chloride	75014	0.01	5	2		930 V				646		10 D
Xylene, m-	108383	< 0.2	< 70		32 T	1.8 T Eco						< 100
Xylene, o-	95476	< 0.2	< 70			350 NZ						< 100
Xylene, p-		< 0.2	< 70									< 100
Xylenes	1330207	0.2	70	10,000	230 T	13 T					10,000 v	100 D

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Sources

1 – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has been done here.
Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel, 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water: updated proposal for first series of compounds. Nat. Inst. Public Health and the Env., and subsequent updates as published elsewhere.
Min. Housing, Spatial Plan. And the Env., 2000. Annexes Circular on target values and intervention values for soil remediations.

2 – Primary entry is the US EPA MCL value, followed by the lower of appropriate WHO, Canadian, or British Columbia guidelines.
Maximum Contaminant Levels (MCLs): http://www.epa.gov/safewater/index.html
W – World Health Organization's (WHO) Drinking water guidelines: http://www.who.int/water_sanitation_health/dwq/en/
C – Canadian Environmental Quality Guidelines for Community Water, Summary Table Update 2002: http://www.ccme.ca
BC – British Columbia Water Quality Guidelines (either working or recommended): http://www.env.gov.bc.ca/wat/wq/

3 – Primary entry is the US Ambient Water Quality Criteria, followed by the lowest of Tier II SAVs or available standards or guidelines.
Lowest Observable Effect Levels (LOELs) previously published by EPA are also included since these essentially were the basis for many state standards.
EPA Ambient water Quality Criteria (AWQC): http://www.epa.gov/waterscience/criteria/aqlife.html
T – Tier II Secondary Acute Value: http://www.esd.ornl.gov/programs/ecorisk/tools.html
Eco – EPA EcoUpdate, Ecotox Thresholds, EPA 540/F-95/038
CA – Canadian water Quality Guidelines: http://www.ec.gc.ca/CEQG-RCQE/English/Cegg/Water/default.cfm
BC – British Columbia Water Quality Guidelines (either working or recommended): http://www.env.gov.bc.ca/wat/wq/
EU – European Union (EU) Environmental Quality Standards: COM(2006) 397 and 398 final.
V – US EPA Region V Ecological Screening Levels: http://www.epa.gov/reg5rcra/ca/edql.htm

4 – Toxicological Benchmarks for Effects on Earthworms: http://www.esd.ornl.gov/programs/ecorisk/tools.html
EPA – Eco-SSL for Invertebrates: http://www.epa.gov/ecotox/ecossl/
Region V Ecological Screening Level for Invertebrates: http://www.epa.gov/reg5rcra/ca/

5 – Entry is lower of either:
Region V Ecological Screening Level for shrew or vole: http://www.epa.gov/reg5rcra/ca/
EPA – Eco-SSL for Mammals: http://www.epa.gov/ecotox/ecossl/

6 – Toxicological Benchmarks for Effects on Terrestrial Plants: http://www.esd.ornl.gov/programs/ecorisk/tools.html
V – EPA Region V Ecological Screening Level for Plants: http://www.epa.gov/reg5rcra/ca/

7 – Entry is lower of either:
M – Toxicological Benchmarks for Effects on Microbes: http://www.esd.ornl.gov/programs/ecorisk/tools.html
A – Eco-SSL for Avian Receptors: http://www.epa.gov/ecotox/ecossl/
D – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. See #1 above for sources.

Screening Quick Reference Table for PCB Composition

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Degree of Chlorination	A1221 Wt %	A1232 Wt %	A1016 Wt %	A1242 Wt %	A1248 Wt %	A1254 Wt %	A1260 Wt %	A1262 Wt %
Biphenyl	11.7 [a]	6.2 [a]						
∑1 Cl	65.5	31.3	Tr (#1, 3)	Tr (#1, 3)				
∑2 Cl	30.0	26.1	15.2	11.5	Tr (#7, 8)			
∑3 Cl	3.5	21.7	58.2	51.0	21.8	2.1		
∑4 Cl	Tr	15.0	26.5	29.0	60.2	14.3	Tr (#52, 70, 74)	Tr (#52, 70, 74)
∑5 Cl	Tr (#95)	5.8	Tr (#91, 95, 102)	8.5	17.1	53.2	8.2	3.5
∑6 Cl				Tr (#136, 138)	0.8	26.6	47.2	31.6
∑7 Cl					Tr	3.8	37.6	45.8
∑8 Cl						Tr (#202)	6.3	17.7
∑9 Cl							0.7	1.3
Total	99.1%	99.94%	99.95%	100%	99.93%	99.95%	100.01%	99.98%
Prominent congeners [b]	1 3 8 4 15 6	1 8 3 4 15 28	18 28 8 31 33 16	18 28 31 8 33 16	66 70 64 28 52 60	118 110 101 95 138 153	180 138 149 187 174 170	180 153187 149 174 203
Unique congener	#11 Tr					#137	#189 Tr	
Peak Range [c]	1-48	1-74	2-50	2-82	8-106	8-107	31.1-117	31.1-117
Ratio #118:203 [d]	Neither	No #203	Neither	No #203	73	370 - 1230	0.3 – 0.5	0.1
Ratio #31:118 [e]	No #118	4.3	No #118	8.5 - 9.2	2.1	0.01 – 0.04	0.1	No #31
Wt % of #153 [f]				0.1 - 0.14	Tr - 0.52	4.7-6.1	11.0 – 12.2	
Additional Information		~ 1:1 mix of 1221-1242	Distillation of 1242					

Notes

Commercial PCBs were manufactured by chlorination of biphenyl to produce complex mixtures (Aroclors in the USA and Great Britain, Clophens in Germany, or Kanechlors in Japan), each containing 60 to 90 different molecular species *(congeners)* and a specified weight percent of chlorine (for example, 54% in Aroclor 1254). There are 209 distinct congener structures possible, of which about 140 to 150 have been detected at significant levels in commercial PCBs.

Congener distributions in environmental samples roughly resemble those of the parent commercial mixtures, but are often modified due to evaporation, water extraction, microbial oxidation or dechlorination, photochemical dechlorination or differential biological uptake and metabolism. Compositional modification from original Aroclor patterns increases in biotic samples with trophic level. Still, it is often useful or necessary to attempt distinguishing the parent mixture released. The following information is presented to provide assistance with initial, preliminary evaluation of Aroclor. *Aroclor assignment should be conducted only by qualified chemists*.

Total PCBs can be characterized by two primary methods – the sum of congeners, or, the sum of estimates of individual Aroclor concentrations. In lower trophic level samples, these two methods provide approximately equal estimates of total PCBs. At higher trophic levels, analyses of samples tend to overestimate total PCBs by as much as 2-fold using the sum of Aroclor method, due to an overestimation of Aroclor 1254.

Tr - Individual congeners are at trace levels - 0.05 to 0.5% each - and are not included in totals.
- Refers to IUPAC congener number. IUPAC #s 107, 108, 109, 199, 200, 201 correspond to BZ#s 108, 109, 107, 201, 199, and 200, respectively.
a – Biphenyl figures are not reflected in congener weight percentages.
b – The six most prominent peaks listed by IUPAC congener number.
c – In the 118 peak numbering system, peak 1 is biphenyl.
d – This ratio is often used as an indicator for Aroclor 1260.
e – This ratio is often used as an indicator for Aroclor 1248.
f – Congener 153 is persistent in biota and abundantly present in higher chlorinated Aroclors and so provides a degree of modification estimate for biotic samples (increasing modification with decreasing PD values):

$$PD_{153} = \left[\frac{\#153_{theory} - \#153_{sample}}{\#153_{sample}} \right] * 100$$

Screening Quick Reference Table for Toxic Equivalency Factors

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Compound	2005 Mammals / human TEF	1998 Fish TEF	1998 Avian TEF
CHLORINATED DIBENZO-P-DIOXINS			
2,3,7,8-TCDD	1	1	1
1,2,3,7,8-PeCDD	1	1	1
1,2,3,4,7,8-HxCDD	0.1	0.5	0.05
1,2,3,6,7,8-HxCDD	0.1	0.01	0.01
1,2,3,7,8,9-HxCDD	0.1	0.01	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.001	<0.001
OCDD	0.0003	<0.0001	< 0.0001
CHLORINATED DIBENZOFURANS			
2,3,7,8-TCDF	0.1	0.05	1
1,2,3,7,8-PeCDF	0.03	0.05	0.1
2,3,4,7,8-PeCDF	0.3	0.5	1
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.01
OCDF	0.0003	<0.0001	0.0001
NON-ORTHO-SUBSTITUTED PCBS			
3,3#,4,4#-tetraCB (PCB 77)	0.0001	0.0001	0.05
3,4,4#,5-tetraCB (PCB 81)	0.0003	0.0005	0.1
3,3#,4,4#,5-pentaCB (PCB 126)	0.1	0.005	0.1
3,3#,4,4#,5,5#-hexaCB (PCB 169)	0.03	0.00005	0.001
MONO-ORTHO-SUBSTITUTED PCBs			
2,3,3#, 4,4#-pentaCB (PCB 105)	0.00003	<0.000005	0.0001
2,3,4,4#,5-pentaCB (PCB 114)	0.00003	<0.000005	0.0001
2,3#,4,4#,5-pentaCB (PCB 118)	0.00003	<0.000005	0.00001
2# ,3,4,4# ,5-pentaCB (PCB 123)	0.00003	<0.000005	0.00001
2,3,3#, 4,4#,5-hexaCB (PCB 156)	0.00003	<0.000005	0.0001
2,3,3#,4,4#,5#-hexaCB (PCB 157)	0.00003	<0.000005	0.0001
2,3#,4,4#,5,5#-hexaCB (PCB 167)	0.00003	<0.000005	0.00001
2,3,3#, 4,4#, 5,5#-heptaCB (PCB 189)	0.00003	<0.000005	0.00001

It has been well established that 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), and other chlorinated dioxins, furans, and even PCBs with a similar planar chemical structures are capable of inducing similar toxicity, such as carcinogenicity. Since these compounds generally are observed in mixtures, it is desirable to be able to express the cumulative, overall toxicity of the mixture. However, since each of these congeners does not exhibit the same degree, or potency, of toxicity, some manipulations of raw concentrations are required to express total toxicity.

A number of systems have been developed to express the total, overall toxicity from mixtures of these chemicals. Most commonly, the potency of each congener is weighted relative to a standard, generally the most potent congener. For dioxins and furans, 2,3,7,8-TCDD is the common standard which is given a reference value of one. The weighting, or potency factor, is called a Toxic Equivalency Factor (TEF). When cumulative results are reported, the absolute concentration of each congener is multiplied by its corresponding TEF to derive a TCDD-equivalency. These values are then summed together to give a total Toxic Equivalency Quotient, or TEQ.

The TEQ scheme refers ***only*** to adverse effects (e.g., cancer) following interactions with certain cellular enzyme systems (the Ah receptors). Other toxic effects of dioxins and dioxin-like compounds are not quantified by this method. Because they involve potency to specific enzyme systems, TEF values vary for different animal species.

There are two main schemes:

The two most common systems for determining TEQs are:

1) **I-TEF and I-TEQ:** The older International Toxic Equivalent (I-TEQ) scheme by the North Atlantic Treaty Organization (NATO) initially set up in 1989 and later extended and updated.

2) **WHO-TEF and WHO-TEQ** (also referred to as TEF or TEQ): More recently, the World Health Organization (WHO) suggested modified Toxic Equivalency Factor (TEF) values for human risk assessment.

ITEQs are most common in North America, while Asia and Europe tend to use WHO-TEQs. On average, the result of TEQ-calculations is about 10% higher when I-TEFs are used compared to when WHO-TEFs are used.

Potency in fish reflects mainly rainbow trout: potency for birds is mainly derived from chickens.

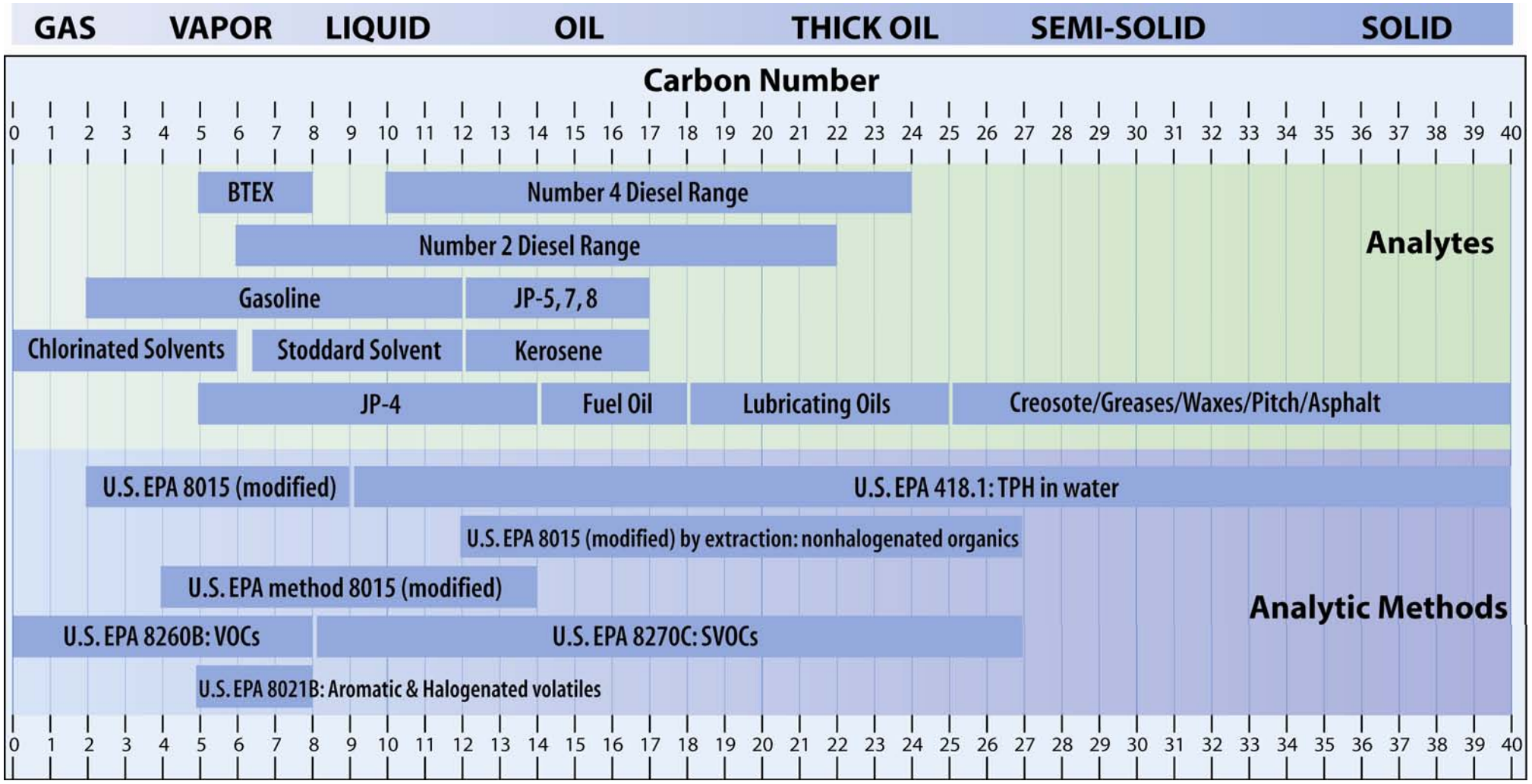
Sources

Van den Berg, M., and others. 1998. “Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, and PCDFs for Humans and Wildlife.” *Environmental Health Perspectives*. Volume 106. Pages 775 - 792.

Van den Berg, M., and others. 2006. “The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds.” *Toxicological Sciences* 93(2):223-241.

Screening Quick Reference Tables for Composition by Carbon Range

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.



Carbon ranges are approximate: actual carbon ranges for a specific product are dependent upon the distillation process of the exact source.

Analytic Methods generally refer to EPA SW-846 methods (www.epa.gov/SW-846/index.htm)

Screening Quick Reference Tables for Sample Collection and Storage

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

MATERIAL	CONTAINER	PRESERVATION	MAXIMUM HOLDING TIME	SAMPLE SIZE
INORGANICS				
Chromium^{+6} (Cr^{+6})	P,G	Cool, 4ºC	24 hours	400 mL/200 g
Mercury (Hg)	P,G	HNO_3, to pH <2	28 days	400 mL/200 g
Metals, except Cr^{+6} and Hg	P,G	HNO_3, to pH <2	6 months	600 mL/200 g
Cyanide by method no. 9010	P,G	Cool 4ºC, pH >12 See method 9010	14 days	1,000 mL
Alpha, Beta, and Radium Radiation	P,G	HNO_3 to pH <2	6 months	1,000 mL
ORGANICS				
Benzidines	G, TLC	Cool, 4ºC	7 days until extraction, 40 days after extraction	1,000 mL
Chlorinated Hydrocarbons	G, TLC	Cool, 4ºC[3]	7 days until extraction, 40 days after extraction	1,000 mL
Dioxins and Furans	G, TLC	Cool, 4ºC[3]	30 days until extraction, 45 days after extraction	1,000 mL
Haloethers	G, TLC	Cool, 4ºC[3]	7 days until extraction, 40 days after extraction	1,000 mL
Nitrites	G, TLC	Cool, 4ºC[3]	14 days	
Nitrosamines	G, TLC	Cool, 4ºC[3]	7 days until extraction, 40 days after extraction	1,000 mL
Nitroaromatics and Cyclic Ketones	G, TLC	Cool, 4ºC[3]	7 days until extraction, 40 days after extraction	1,000 mL
OIL And GREASE	G	Cool, 4ºC[2]	28 days	1,000 mL
TOTAL Organic Carbon, By Method No. 9060	P,G	Cool, 4ºC[2] store in the dark	28 days	100 mL
TOTAL Organic Halides By Method No. 9020/9021	G, TLC	Cool, 4ºC[2]	28 days	500 mL
PCBs	G, TLC	Cool, 4ºC	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Pesticides	G, TLC	Cool 4ºC,	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Phenols	G, TLC	Cool, 4ºC[3]	7 days until extraction, 40 days after extraction	1,000 mL
Phthalate Esters	G, TLC	Cool, 4ºC	7 days until extraction, 40 days after extraction	1,000 mL
Polynuclear Aromatic Hydrocarbons	G, TLC	Cool, 4ºC[3] store in the dark	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Purgeable Aromatic Hydrocarbons	VOA	Cool, 4ºC[2,3]	14 days	40 mL
Purgeable Halocarbons	VOA	Cool, 4ºC[3]	14 days	40 mL

Sources

EPA SW846

1 P - Polyethylene; G - Amber glass containers; TLC - Teflon-lined cap; VOA - Volatile organic analyte vial of amber glass with teflon-lined septum.
2 Adjust to pH <2 with H_2SO_4, HCl, or solid $NaHSO_4$
3 Free chlorine must be removed before addition of HCl by exact addition of $Na_2S_2O_3$

Screening Quick Reference Table
Options for Selection of Analytical Methods: Inorganics

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

TRACE ELEMENT	OTHER [1]	FLAME AA	FURNANCE AA	ICP	EXTRACTION METHODS	
					WATER	SOIL/SEDIMENT
Aluminum (Al)	6800	7020		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Antimony (Sb)	6200(55) 6800	7040	7041 7062 [3]	6010B 6020A	3005A 3015A	3050B 3051A
Arsenic (As)	6200(60) 7063 7061A [3]		7060 7062 [3]	6010B 6020A	3005A 3010A 3015A 7063	3050B 3051A
Barium (Ba)	6200(60) 6800	7080A	7081 [3]	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Beryllium (Be)		7090	7091	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Cadmium (Cd)	6200 6800	7130	7131A	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Calcium (Ca)	6200 6800	7140		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Chromium (CR), total	6200(200) 6800	7190	7191	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Chromium+6 (Cr+6)	7195 — 7199 [3]				7195 - 7199	3060A
Cobalt (Co)	6200(330)	7200	7201	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Copper (Cu)	6200(85) 6800	7210	7211 [3]	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Iron (Fe)	6200 6 800	7380	7381 [3]	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Lead (Pb)	6200(45) 6800	7420	7421	6010B 6020A	3005A 3010A 3015A 3020A	3051A
Magnesium (Mg)	6800	7450		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Manganese (Mn)	6200(240)	7460	7461	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Mercury (Hg)	4500(0.5) 6200 6800 7470A 7471B 7472 7473 7474 [3]			6020A	7470A 7472 3015A	3051A 7471B 7473 7474
Molybdenum (Mo)	6200(25) 6800	7480	7481	6010B	3005A 3010A 3015A 3020A	3050B 3051A
Nickel (Ni)	6200(100) 6800	7520	7521	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Potassium (K)	6200 6800	7610		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Selenium (Se)	6200 6800 7741A 7742 [3]		7740	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Silver (Ag)	6200 6800	7760A	7761 [3]	6010B 6020A	3005A 3015A	3051A 7760 7761
Sodium (Na)		7770		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Strontium (Sr)	6200(30) 6800	7780		6010B	3015A	3050B 3051A
Thallium (Tl)	6200 6800	7840	7841	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Tin (Sn)	6200(85)	7870				
Vanadium (V)	6200 6800	7910	7911	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Zinc (Zn)	6200(80) 6800	7950	7951 [3]	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Cyanide (HCN)	9010B — 9014 [3]					

Sources

All method numbers refer to EPA SW-846, Volume III with changes as proposed for Volume IV.
ICP's advantage is that it allows simultaneous or rapid sequential determination of many elements, but suffers from interferences. AA determinations are normally completed as single element analyses. ICP and Flame AA have comparable detection limits (within a factor of 4), but ICP-MS (6020A) can drastically improve the detection limits (e.g., an order of magnitude lower). Furnace AA generally exhibits lower detection limits than ICP or Flame-AA, and offers more control over unwanted matrix components. X-RAY and immunoassays allow field determinations.

1 Method 6200 is Portable X-Ray; 6800 is Elemental/Isotope Mass Spec.; 4500 is Immunoassay; 7063 is ASV; where available, soil detection limits in ppm are in parentheses.
2 Except as noted, most individual procedures are proposed to be integrated into Method 7000B or 7010.
3 Includes various methods. Follow the extraction procedure detailed in the individual determinative method.

Screening Quick Reference Table
Options for Selection of Analytical Methods: Organics

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
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COMPOUNDS	FIELD METHODS	OC/MS METHOD	SPECIFIC DETECTION METHOD	HPLC METHOD	EXTRACTION METHODS WATER	EXTRACTION METHODS SOIL/SEDIMENT	CLEANUP METHOD
Aromatic and Halogenated Volatiles		8260B	8021B		5021 5030B 5032	5021 5032 5035	
Carbamates				8318 8321B	8318 8321B	8318 8321B	8318
Chlorinated Dioxins and Furans			8280B 8290A		8280B 8290A	8280B 8290A 3545A	8280B 8290A
Chlorinated Hydrocarbons		8270D	8121		3510C 3520C 3535A	3540C 3550B	3620B 3640A
Chlorinated Phenoxyacids	4015 (0.1 ppm)	8270D 2	8151A	8321B	8151A 8321B 3535A	8321B 8151A 3545A 3580A	8151A 3620B
Haloethers		8270D	8111		3510C 3520C	3540C 3545 3550B	3620B 3640A
Nitriles and Amides		8260B	8031 8032A 8033	8315 8316	5030B — 5032 8031 8032A 8316	5031 5032 5035	8032A
Nitroaromatics and Ketones		8270D	8091	8330A	3510C 3520C 3535A	3540C 3545 3550B	3620B 3640A
Nitroaromatics (Explosives)	4050 (0.5 ppm) 4051 8515 (1 ppm)			8330A - 8332	8330A — 8332	8330A — 8332	8330A — 8332 3620B
Nitrosamines		8270D	8070A		3510C 3520C 8070A	3540C 3545 3550B 8070A	3610B 3620B 3640A 8070A
Non-Halogenated Volatiles		8260B	8015B		5030B — 5032	5021 5031 5032 5035	
Organochlorines	4040 — 4042 (0.2 to 20 ppm)	8270D 2	8081B 8275A		3510C 3520C 3535A	3540C 3545A 3550B 3562	3620B 3630C 3640A 3660
Organophosphates		8270D 2	8141B	8321B	3510C 3520C 3535A	3540C 3545A 3550B	3620B
PAHs	4035 (1 ppm)	8270D	8100 8275A	8310	3510C 3520C	3540C 3545 3550B 3561	3610B 3630 3640A 3650B
PCBs	4020 (5 ppm) 9078 (2 ppm)	8270D 2	8082A 8275A		3510C 3520C 3535A	3540C 3545A 3550B 3665A 3562	3620B 3630C 3640A 3660 3665A
Phenolics	4010A (0.5 ppm)	8270D	8041		3510C 3520C	3540C 3545 3550B	3630 3640A 3650B 8041
Phthalates		8270D	8061A		3510C 3520C 3535A	3540C 3545 3550B	3610B 3620B 3640A
Semi-Volatile Organics		8270D			3510C 3520C 3535A	3540C 3545A 3550B	3640A 3650B 3660
Total Organic Halides (TOX)			9020B 9022		9020B 9022		
Total Petroleum Hydrocarbons	4030 (5 ppm) 9074		8015B				
Volatile Organics		8260B	8015B 8021B		5030B — 5032	5021 5031 5032 5035	

Sources

All method numbers refer to EPA SW-846, Update III, with changes as proposed in Update IV.

Options shown are generally for chemical classes; more detailed information may be available for specific compounds

GC/MS methods allow for scanning a broad range of volatile and semi-volatile compounds, but suffer from interference and higher detection limits.

Specific determination methods and HPLC methods allow for more precise determinations of specific compounds of interest.

1 Series 4000 are immunoassays and are for specific compounds within these classes (i.e., 2,4-D, TNT, RDX, and PCP). Soil detection limits are in parentheses.
2 This is not a method of choice, but rather a confirmatory method.

Screening Quick Reference Tables

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels.
All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

Because trace elements are naturally occurring compounds, concentrations reflective of non-anthropogenically impacted, or "background," are provided in addition to toxicological benchmarks. For screening, trace element levels may be compared to the geometric mean (and range) observed in natural soils in the U.S. Further comparisons to regional values is encouraged.

Promulgated criteria or standards for sediments or soils are generally not available in the U.S. For screening purposes, contaminant levels in solids (sediment or soil) may be compared to benchmarks representative of different characterizations of ecological risk. They should ***not*** be applied without a reasonable understanding of their development, their performance, and their limitations.

The NOAA SQuiRTs include multiple sediment screening values to help portray a spectrum of concentrations which have been associated with various probabilities of adverse biological effects. This spectrum ranges from presumably nearly non-toxic to toxic levels. For instance, if all analytes screen below lower-threshold values (for example, TELs), this suggests, with a high degree of confidence, that a sample with these levels of contaminants has a low probability of being toxic, as tested through standard bioassays. Conversely, exceeding lower thresholds does ***not*** necessarily predict toxicity. Comparison to higher toxicity thresholds (for example, PELs) identifies compounds which are more probably present at elevated, toxic levels.

Sources of benchmarks for sediment were chosen primarily on the basis of representing a fairly unique approach for their derivation. A major exception is the "Consensus TEC/PEC" values: these values are simply averages of other existing benchmarks (mostly those appearing in the SQuiRT cards). The consensus TEC/PECs are provided here merely as a service.

For soil- and sediment-associated contaminants, dry weight concentrations are screened directly against published benchmarks. Some benchmarks are available only on a Total Organic Carbon (TOC) normalized basis, and are footnoted as such. Separate values are provided for either freshwater and estuarine or marine sediments.

For freshwater sediments, the Upper Effects Threshold (UET) was derived by NOAA as the lowest AET from a compilation of endpoint analogous to the marine AET endpoints. The UETs for organic contaminants are generally listed for a sediment containing 1% TOC.

This version of the SQuiRT cards adds a section on the composition of PCBs. A characterization of Aroclors by their degree of chlorination and congener patterns may aid in *preliminary* exploration of source type. Definitive Aroclor assignment should only be conducted by a qualified chemist.

To express cumulative toxicity from mixtures of dioxins and furans, Toxic Equivalency Factors are included in this version of the SQuiRT cards. Absolute concentrations can be multiplied by the TEF potency factors and the products then summed to derive total toxicity.

Every effort has been made to ensure accuracy in these SQuiRT cards. However, NOAA is not liable for errors in original sources or revision of values. These screening values are subject to change as new data become available. The SQuiRT cards may be freely reproduced and distributed, if they are distributed in their entirety, without modification, and properly credited to NOAA.

The SQuiRT cards should be cited as:

"Buchman, M. F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoriation Division, National Oceanic and Atmospheric Administration, 34 pages."

USEPA MCLs
(May 2009)

National Primary Drinking Water Regulations

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	zero
OC	Alachlor	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
R	Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
IOC	Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
IOC	Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	0
IOC	Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
OC	Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
IOC	Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
OC	Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
OC	Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
IOC	Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
R	Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
DBP	Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
IOC	Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
OC	Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04
OC	Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	zero
D	Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	MRDLG=4[1]
OC	Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	zero
D	Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	MRDLG=4[1]
D	Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	MRDLG=0.8[1]
DBP	Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	0.8
OC	Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.1
IOC	Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	0.1
IOC	Copper	TT[5]; Action Level = 1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	1.3
M	*Cryptosporidium*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero

LEGEND

D Disinfectant | IOC Inorganic Chemical | OC Organic Chemical

DBP Disinfection Byproduct | M Microorganism | R Radionuclides

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
IOC Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2
OC 2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.07
OC Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	0.2
OC 1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	zero
OC o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.075
OC 1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC 1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	0.007
OC cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	0.07
OC trans-1,2-Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	0.1
OC Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories	zero
OC 1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	0.4
OC Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	zero
OC Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	0.007
OC Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	zero
OC Diquat	0.02	Cataracts	Runoff from herbicide use	0.02
OC Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	0.1
OC Endrin	0.002	Liver problems	Residue of banned insecticide	0.002
OC Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	zero
OC Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	0.7
OC Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	zero
M Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	zero[6]
IOC Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	4.0
M *Giardia lamblia*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	0.7
DBP Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	zero
OC Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	zero
M Heterotrophic plate count (HPC)	TT[7]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	n/a

LEGEND

D Disinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	zero
OC	Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	0.05
IOC	Lead	TT5; Action Level=0.015	Infants and children: Delays in physical or or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	zero
M	*Legionella*	TT7	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	zero
OC	Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens	0.0002
IOC	Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	0.002
OC	Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock	0.04
IOC	Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	10
IOC	Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
OC	Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
OC	Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
OC	Picloram	0.5	Liver problems	Herbicide runoff	0.5
OC	Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
R	Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
IOC	Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
OC	Simazine	0.004	Problems with blood	Herbicide runoff	0.004
OC	Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
OC	Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
IOC	Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
OC	Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
M	Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	zero
DBP	Total Trihalomethanes (TTHMs)	0.080	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC	Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
OC	2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
OC	1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07
OC	1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	0.2
OC	1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	0.003
OC	Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	zero

LEGEND

D Disinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
M Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	n/a
R Uranium	30µg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	zero
OC Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	zero
M Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	10

LEGEND

D Disinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

NOTES

1 Definitions

- Maximum Contaminant Level Goal (MCLG)—The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- Maximum Contaminant Level (MCL)—The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- Maximum Residual Disinfectant Level Goal (MRDLG)—The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Maximum Residual Disinfectant Level (MRDL)—The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Treatment Technique (TT)—A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or *E. coli*-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or *E. coli*-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or *E. coli*-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium*: 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- Giardia lamblia: 99.9 percent removal/inactivation
- Viruses: 99.99 percent removal/inactivation
- *Legionella*: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated according to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlled.
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelolometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter
- Long Term 1 Enhanced Surface Water Treatment; Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- Long Term 2 Enhanced Surface Water Treatment; This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- Filter Backwash Recycling: The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive TC-positive samples, and one is also positive for *E. coli* or fecal coliforms, system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

National Secondary Drinking Water Regulation

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

For More Information

EPA's Safe Drinking Water Web site:
http://www.epa.gov/safewater/

EPA's Safe Drinking Water Hotline:
(800) 426-4791

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at :
(800) 490-9198, or
email: nscep@bps-lmit.com.

United States Environmental Protection Agency

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KDHE RSK Manual – 5th Version
(October 2010)

RISK-BASED STANDARDS FOR KANSAS

RSK MANUAL – 5TH VERSION

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

BUREAU OF ENVIRONMENTAL REMEDIATION

OCTOBER 2010

PREFACE:

The Kansas Department of Health and Environment (KDHE)/Bureau of Environmental Remediation (BER) originally developed the Risk-Based Standards for Kansas (RSK) Manual in March of 1999. Chemical-specific and media-specific risk-based cleanup goals were calculated using guidance and directives from the United States Environmental Protection Agency (EPA) and various other technical resources. Prior to initial development of the RSK Manual, an Environmental Workgroup was established consisting of members of industry and the public to assist in determining appropriate risk-based cleanup levels. The risk-based cleanup levels determined by the Environmental Workgroup are incorporated into the RSK Manual. The RSK Manual assists KDHE/BER project managers to fairly and consistently address contaminated sites in the State of Kansas.

This October 2010 RSK Manual, the fifth edition, replaces the June 2007 edition. All previous editions are obsolete and should not be used for future decisions related to the characterization or remediation of contaminated properties/sites. This October 2010 RSK Manual contains several updates to the existing text, tables, and appendices, including the following significant changes:

- KDHE/BER has updated all of the contaminant specific parameters in Appendix B and the contaminant toxicity data in Appendix C to be consistent with current available information.
- KDHE/BER has updated the default parameters in the exposure equations to be consistent with current EPA guidance.
- KDHE/BER has modified the exposure equations to incorporate the use of EPA's current inhalation toxicity units. Inhalation reference concentration (RfC) has replaced inhalation reference dose (RfDi) for non-carcinogenic toxicity; inhalation unit risk (IUR) has replaced inhalation cancer slope factor (SFi) for carcinogenic toxicity.
- KDHE/BER has modified Appendix A to include a separate column for the calculated soil saturation value for each organic contaminant. The user should remember to use this value in conjunction with the values in the soil pathway column (based on health risk) and the soil to groundwater column.
- KDHE/BER has removed the risk-based cleanup levels for polychlorinated biphenyls (PCBs). BER project managers and the regulated community will address PCB-contaminated media according to BER policy.

The RSK Manual is only applicable to contaminated properties or sites participating in appropriate state cleanup programs. Use of risk-based values established within the RSK Manual without KDHE/BER oversight may constitute misapplication of the RSK Manual and may result in risk management decisions not supported by KDHE/BER. A more detailed discussion of the appropriate use of the RSK Manual is included in Section 2.2.

OCTOBER 2010

RISK-BASED STANDARDS FOR KANSAS

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RISK-BASED STANDARDS FOR KANSAS

1.0 INTRODUCTION

The Risk-Based Standards for Kansas (RSK) Manual is a guidance document which describes the process for establishing chemical-specific and site-specific cleanup goals for soil, groundwater, and indoor air that are protective of human health and the environment. This document was created to establish a consistent and streamlined decision-making process for addressing contaminated sites managed by the Kansas Department of Health and Environment (KDHE)/Bureau of Environmental Remediation (BER). The RSK Manual is meant to serve as a tool for evaluation of the need for additional assessment or cleanup at contaminated sites, when considered in conjunction with other site-specific conditions. The RSK Manual is a compilation of risk-based cleanup goals for contaminants in soil and groundwater for which federal standards have not been established; groundwater cleanup goals based on federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs) for public drinking water supplies; risk-based acceptable concentrations of contaminants in indoor air at residences; and supporting chemical, physical, and toxicological properties for the contaminants considered herein.

The procedures and methodologies contained in this document have been employed to be consistent with federal guidance and directives to assess potential human health risk posed by exposure to environmental contamination. Federal guidance and directives were established subsequent to the promulgation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). KDHE believes that proper employment of this manual will result in risk-based remediation that is consistent with federally promulgated standards, including the Safe Drinking Water Act, and is protective of human health as defined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

KDHE calculated the chemical-specific and media-specific risk-based cleanup goals in this document using guidance and directives from the United States Environmental Protection Agency (EPA) and other technical resources, which are referenced throughout this document and listed in Section 8.0, "REFERENCES." This document is the fifth version of the Risk-Based Standards for Kansas Manual and supercedes all previous versions.

2.0 PUBLIC USE OF THE RSK MANUAL

2.1 Benefits of the RSK Manual

The primary benefit of the RSK Manual is the predetermination of acceptable cleanup goals without requiring the performance of costly and time-consuming baseline risk assessments and/or contaminant fate and transport models. The RSK Manual provides the public with a streamlined,

cost-effective approach to determine whether some form of remedial action is warranted at a contaminated site**.** Use of the RSK Manual by Kansas industry, Kansas residents, and KDHE/BER will also promote consistency of remedial requirements at contaminated sites and ensure that remedial actions are protective of human health and the environment. The RSK Manual promotes flexibility by providing tabulated risk-based cleanup goals as well as the opportunity to develop site-specific cleanup goals based on factors including land use and institutional controls.

2.2 Limitations of Use

The RSK Manual is only applicable to contaminated properties or sites that are participating in appropriate state cleanup programs. KDHE/BER project managers will work with the public and regulated community to ensure appropriate application of this guidance. Risk-based cleanup levels defined in this manual are applicable for a single contaminant, in a single medium, under standard and conservative default exposure assumptions. Risk-based cleanup levels have several additional limitations. Specifically excluded from consideration in the RSK Manual are cumulative risk from multiple contaminants or media, relative source contribution, and risk to ecological receptors. KDHE/BER recommends consideration of the following additional limitations when using the RSK Manual:

- Additional state, federal, and/or local laws or regulations may be applicable at certain sites. Examples of such applicable or relevant and appropriate requirements include local public health laws and ordinances, requirements of groundwater management districts, zoning for land use designation, and compliance with Resource Conservation and Recovery Act (RCRA) regulations.
- Aesthetic or other criteria may drive the need for remediation independent of risk-based standards.
- The risk-based cleanup values for soils do not apply to sediments. Users of the RSK Manual must consult with the KDHE/BER project manager regarding appropriate sediment screening and remediation goals, and also follow KDHE/BER policy "BER-ARS-045 - Sediment Policy."
- The risk-based cleanup values for groundwater do not apply to surface water. Surface water cleanup levels shall meet the Kansas surface water quality criteria as established in K.A.R. 28-16-28.

The RSK Manual should not be used for environmental audits, environmental assessments, or other non-KDHE/BER managed activities. Use of risk-based values established within the RSK Manual without KDHE/BER oversight may constitute misapplication of the RSK Manual and may result in risk management decisions not supported by KDHE/BER. The RSK Manual is not intended for use by environmental consultants on contaminated sites in the State of Kansas that are not participating in a KDHE/BER cleanup program. The KDHE/BER project manager will make the final determination if the risk-base cleanup values in this manual are appropriate for the current and future use of a contaminated site.

3.0 TIERED APPROACH

A primary goal of KDHE/BER programs is to insure contaminated sites are remediated to the extent necessary to protect the public from unacceptable risks potentially caused by exposure to contaminated media. The RSK Manual provides a tiered approach for establishing cleanup goals at contaminated sites in Kansas. The tiers are summarized as follows:

- Tier 1 is a comparison of the concentration of a naturally occurring contaminant to the background concentration of that contaminant in the affected medium, using methods approved by KDHE/BER to determine background.
- Tier 2 is a comparison of the concentration of a contaminant to the risk-based cleanup values in the KDHE Tier 2 Risk-Based Summary Table, found in Appendix A of this document.
- Tier 3 involves collecting the necessary data, under KDHE/BER direction, to replace default values in the Tier 2 equations with site-specific information.

The following sections of the RSK Manual contain detailed information on definitions, formulas, input parameters and the use of the three tiers, including a discussion of the rationale and process for determining soil and groundwater cleanup levels for contaminated sites.

The tiered approach presented in the RSK Manual is not acceptable at all contaminated sites. In some instances, KDHE/BER may require a full baseline risk assessment. Examples of such instances include sites at which a cumulative risk from multiple contaminants must be examined and sites at which the remedial efforts must be consistent with the NCP. Coordination with the appropriate state program is necessary to determine if the tiered approach in the RSK Manual is applicable to a contaminated site.

3.1 Tier 1 - Comparison to Background

Tier 1 cleanup levels may be determined for contaminants of concern that are naturally present in the environment. This class of contaminants includes metals such as lead, arsenic, cadmium, and chromium, among others, and inorganic pollutants such as nitrate and chloride, among others. In addition, certain substances that are endemically enriched in various environments, such as industrial tracts or agricultural lands, as a result of their widespread employment by humans may be evaluated as a Tier 1 contaminant. For sites with naturally-occurring contaminants, KDHE/BER may allow the background concentration to be the cleanup goal in that medium.

To establish Tier 1 cleanup levels, background concentrations of naturally-occurring contaminants must be determined at the site. If pre-existing background environmental quality data is not available or not representative of the site, then the collection and analysis of background samples will be required to determine background environmental quality. A site-specific number of samples, approved by KDHE/BER, must be collected. Review and approval of the background sampling plan by the KDHE/BER project manager is necessary prior to the collection of any background samples.

3.2 Tier 2 Risk-Based Summary Table

Appendix A of the RSK Manual is the Tier 2 Risk-Based Summary Table. The table contains chemical-specific, risk-based cleanup values for over 190 contaminants in soil and groundwater, including metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and herbicides. These cleanup values, based upon current EPA toxicity values for the contaminants and default exposure factors, represent the concentrations at which the contaminants pose an acceptable human health risk to receptors, including sensitive groups (children or the elderly), over a lifetime.

3.2.1 Contaminant Toxicity

Human health risk can be described as the probability of suffering harm as a consequence of chronic, or long-term, exposure to contaminated media. Contaminants which pose a health risk are generally classified into two separate categories. *Non-carcinogens* are contaminants that lack evidence of increasing the potential for developing cancer over a lifetime. *Carcinogens* are contaminants that may increase the potential for developing cancer over the lifetime of an exposed individual.

For *non-carcinogens* a threshold concentration is quantified for each contaminant based upon clinically-determined critical toxicological effects such as liver damage, kidney damage, central nervous system disorders, etc. The threshold concentration is referred to as a reference dose (RfD) or a reference concentration (RfC). The lower the RfD or RfC value for a contaminant, the more toxic it is relative to contaminants with higher RfDs or RfCs. Exposure to a contaminant concentration below these threshold concentrations should not cause a critical toxicological effect; however, long-term exposure to a contaminant concentration exceeding the RfD or RfC may cause a critical toxicological effect. Risk assessors calculate the ratio of a contaminant concentration to the RfD or RfC to determine the Hazard Index (HI). If the HI is less than or equal to 1, the contaminant concentration is considered acceptable. The Tier 2 cleanup values in Appendix A for non-carcinogens are based upon an HI equal to 1.

For carcinogens, the probability of increasing the potential for developing a cancer as a result of chronic exposure to contaminated media is quantified based upon clinical studies of exposed populations, including humans, where available, or test animals in the absence of documented human exposures. The contaminant-specific carcinogenic risk factor is referred to as a slope factor (SF) for dermal and ingestion exposures, and an inhalation unit risk factor (IUR) for inhalation exposures. The higher the SF or IUR value for a carcinogenic contaminant, the more toxic it is relative to carcinogenic contaminants with lower SF or IUR values. Risk assessors quantify the probability of developing a cancer as a result of chronic exposure to carcinogenic contaminated media by multiplying the contaminant concentration by the contaminant SF or IUR. The resulting value is expressed in terms of one additional cancer incidence per population exposed; for example, one additional cancer incidence per ten thousand (1 in 10,000) exposed individuals, which may be expressed as 1×10^{-4}. For known or suspected carcinogens, EPA acceptable exposure levels are

those that represent an excess upper bound lifetime cancer risk to an individual between 1×10^{-4} and 1×10^{-6}. The Tier 2 cleanup values in Appendix A for carcinogens are based upon a 1×10^{-5} risk.

For the purpose of developing the Tier 2 Risk-Based Summary Table, KDHE/BER used established contaminant-specific toxicity values developed and maintained by the EPA. Toxicological data were obtained from the following sources, listed in order of preference:

1. EPA Integrated Risk Information System (IRIS) website, June 2010
2. EPA Regional Screening Level (RSL) Tables, May 17, 2010
3. EPA Health Effects Assessment Summary Tables (HEAST), July 1997
4. Other EPA documents
5. California Office of Environmental Health Hazard Assessment

For contaminants which lack toxicological data for a given route of exposure, KDHE/BER used route-to-route extrapolations. For example, anthracene has an oral reference dose (RfD), but no toxicological data for the inhalation pathway. KDHE/BER used the RfD to extrapolate an inhalation reference concentration (RfC) for anthracene, to then be used in the inhalation exposure pathway equations for that contaminant.

Contaminant toxicological data are provided in Appendix C. KDHE/BER evaluated the contaminants in Appendix A for both carcinogenic and non-carcinogenic health effects. The determining risk-based concentration is based upon the lower contaminant concentration of the carcinogenic risk or non-carcinogenic risk.

3.2.2 Exposure Factors

Individuals exposed to environmental contaminants are referred to as receptors. For the Tier 2 Risk-Based Summary Table, KDHE/BER has identified two general categories of receptors, residents and non-residents, according to the appropriate land-use designation for each site. The significant differences between the two receptor classes include exposure frequency, exposure duration, and the consideration that children are potentially exposed at residential land-use scenarios and are more sensitive to environmental contaminants. The non-residential land-use scenario is based upon industrial or commercial settings where adult workers are considered the potentially exposed receptor.

Human health risk-based contaminant concentrations for the residential scenario were calculated for soil, groundwater, and indoor air. Contaminant concentrations for non-residential scenarios were calculated for soil and groundwater. The soil exposure pathways evaluated in the human health risk-based calculations include incidental ingestion of soil, inhalation of airborne particulates (dusts), inhalation of chemicals volatilizing from the soil (volatile compounds only), and dermal contact with soil (organic compounds only). The reasoning for evaluating dermal contact for organic contaminants only is based upon chemical-specific absorption factors. In general, inorganic contaminants have a much lower absorption factor than organic contaminants. Exposure pathways

evaluated for groundwater include ingestion, inhalation of chemicals volatilizing from the water (volatile compounds only), and dermal contact with water. The exposure pathway for indoor air is limited to inhalation of volatile organic contaminants.

Default exposure factors were obtained primarily from EPA documents, including *Risk Assessment Guidance for Superfund Supplemental Guidance Standard Default Exposure Factors* (OSWER Directive, 9285.6-03), dated March 25, 1991; and *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, dated July 2004. Exposure factors used in the Tier 2 Risk-Based Summary Table are presented in Table 1, Table 2, and Table 3 for groundwater, soil, and indoor air, respectively.

For the residential land use scenario, child exposure parameters were used to evaluate non-carcinogenic risks in soil, groundwater, and indoor air, since child exposure parameters are more sensitive to this class of environmental contaminants. Adult exposure parameters were used to evaluate carcinogenic risks for residents because, as a result of the methodologies used to calculate risk, the exposure to adults is the most significant receptor category. Adult exposure parameters were used to evaluate both carcinogenic and non-carcinogenic risks for non-residents as they are typically the only receptors in a non-residential land-use scenario.

3.2.3 Groundwater

The Tier 2 Risk-Based Summary Table groundwater concentrations presented in Appendix A are derived with the assumption that aquifers in Kansas are sources of potable water. (For a detailed discussion on aquifer use, RSK Manual users are encouraged to refer to KDHE/BER policy "BER-RS-045 - Considerations for Groundwater Use and Applying RSK Standards to Contaminated Groundwater.") Accordingly, for those contaminants for which the federal Safe Drinking Water Act has promulgated primary maximum contaminant levels (MCLs), Tier 2 groundwater cleanup concentrations for both residential and non-residential land use scenarios are the MCLs. For all other contaminants addressed within this document, cleanup values are risk-based and are the product of Equations 1 and 2, for carcinogenic and non-carcinogenic contaminants, respectively. In the event groundwater is to be used as a source of drinking water, the groundwater cleanup concentration defaults to the residential land use concentration irrespective of land use. Exposure factors used in the equations are provided in Table 1. Contaminant chemical, physical, and toxicological data are provided in Appendices B and C.

Independent of the MCLs and risk-based cleanup standards in Appendix A, KDHE/BER requires remediation at all sites with non-aqueous phase liquid (NAPL) contaminants present in the groundwater.

3.2.4 Soils

KDHE/BER has identified three potential conditions which must be assessed collectively to determine the appropriate Tier 2 concentration for a contaminant in soil. The first condition is impact to human health via ingestion of contaminated soil, inhalation of VOCs and/or fugitive emission dusts, and dermal contact with contaminated soil. The second condition to be assessed is the contaminant concentration in soil which would be protective of groundwater. The third condition is provided for in *Risk Assessment Guidance for Superfund: Volume 1-Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)*, which indicates the soil saturation concentration for each contaminant be quantified to determine the concentration at which it could be reasonably assumed that free phase product is present. The appropriate Tier 2 soil cleanup concentration is the lesser of the calculated values for acceptable impact to human health, the soil saturation concentration, or potential threat to groundwater.

KDHE/BER calculated the risk-based cleanup values for each contaminant in soil using the exposure factors provided in Table 2, the contaminant chemical, physical, and toxicological data provided in Appendices B and C, and Equations 3 and 4 (for carcinogens and non-carcinogens, respectively). For each of the two land use scenarios, the Tier 2 Risk-Based Summary Table provides a soil concentration value for each contaminant based upon the threat to human health. Each chemical-specific concentration has a letter beside to inform the user of the adverse health effect upon which the Tier 2 Soil Pathway is based. For carcinogenic risk, the notation is "c". For non-carcinogenic risk, the notation is "n."

The methodology used to determine soil cleanup levels incorporates the additive adverse human health effects associated with the inhalation of vapors from soil contaminated with VOCs. EPA toxicity data indicate that risks posed from exposure to certain contaminants in soil via the inhalation pathway far outweigh the risks posed via ingestion; therefore, the human health risk-based concentrations have been calculated to address this pathway as well. For the purposes of this document, VOCs are those organic chemicals having a Henry's Law constant greater than 1×10^{-5} atmospheres per cubic meter per mole (atm-m3/mol) and a molecular weight less than 200 grams/mole. To calculate inhalation exposure risk for VOCs, each contaminant's volatilization factor (VF) must first be calculated. The VF is assumed to be 0.5 liters per cubic meter (L/m^3) for volatilization from water to air based upon studies by Andelman 1990. The soil-to-air VF is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to air. The VF equation (Equation 5) represents a dispersion model that simulates the dispersion of contaminants into the atmosphere. Chemical-specific parameters needed to complete the calculation in Equation 5 can be found in Appendix B.

The soil saturation concentration corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the contaminant may be present as a pure liquid phase for contaminants that are liquid at ambient soil temperatures and pure solid phase for compounds that are solid at ambient soil temperatures. The Tier 2 Risk-Based Summary Table includes, for each organic contaminant, a soil saturation concentration calculated by KDHE/BER

using Equation 6. If the chemical-specific soil saturation concentration is less than its corresponding human health risk-based concentration, the soil saturation concentration is to be used as the Tier 2 cleanup value.

3.2.5 Soil to Groundwater Protection

Contaminants leaching from soil to groundwater may pose a significant threat to groundwater quality. Soil contamination cleanups may be driven by chemical-specific soil to groundwater pathway concentrations to protect groundwater quality. The methodology for calculating soil concentrations sufficiently protective to prevent the migration of soil contaminants to groundwater was derived from the document titled, "*Soil Screening Guidance: Technical Background Document,"* OSWER 9355.4-17A, EPA/540/R-95/128 May 1996. The "*Soil Screening Guidance"* document was employed because it is supported by EPA, has been extensively peer-reviewed, and the methodology presented therein is relatively simple.

Migration of a contaminant from soil to groundwater can be simplified for modeling purposes to a two-stage process: (1) release of the contaminant in soil leachate and (2) transport of the contaminant soil leachate through the underlying soil to the aquifer and, conceptually, to a receptor well at that location. For the purposes of this document, KDHE/BER assumes the receptor well to be at the source area; therefore, fate and transport modeling is not an element of the Tier 2 Risk-Based Summary Table. KDHE/BER has adopted EPA's screening dilution factor of 20 for calculating chemical-specific soil-to-groundwater pathway concentrations.

Equation 7 is the soil-to-groundwater equation used to calculate the concentration of a contaminant in soil above which a threat of the contaminant entering the groundwater is a concern. Tier 2 soil-to-groundwater pathway concentrations are back-calculated from acceptable groundwater concentrations (MCLs or human health risk-based concentrations determined using Equations 1 and 2). The acceptable groundwater concentration is multiplied by the dilution factor of 20 to obtain a target leachate concentration.

Although simplified, the methodology described in this section is theoretically and operationally consistent with investigation and modeling efforts that are conducted to develop soil cleanup goals and cleanup levels for protection of groundwater at Superfund sites. Simplifying assumptions for the migration to groundwater pathway include:

- The source is infinite (i.e., steady-state concentrations will be maintained in groundwater over the exposure period);
- Contaminants are uniformly distributed throughout the zone of contamination;
- Soil contamination extends from the surface to the groundwater table (i.e., adsorption sites are filled in the unsaturated zone beneath the area of contamination);
- There is no chemical or biological degradation in the unsaturated zone;
- Equilibrium soil/water partitioning is instantaneous and linear in the contaminated soil;
- The receptor well is at the source area (i.e., there is no dilution from recharge down-gradient of the property and the well is screened within the plume);
- The aquifer is unconsolidated and unconfined (surficial);
- Aquifer properties are homogenous and isotropic;
- There is no attenuation (i.e., adsorption or degradation) of contaminants in the aquifer; and,
- The contaminant does not exist as free product in the soil at the property.

3.2.6 Exceptions to Tier 2 Methodology

For a few contaminants listed in the Tier 2 Risk-Based Summary Table, alternative methods were employed to determine chemical-specific concentrations that are protective of human health, are environmentally safe, or preserve the aesthetic quality of drinking water supplies. Alternative methods include the use of health advisory data in the absence of chemical-specific toxicological data, consideration of drinking water odor and taste thresholds, and the consideration of potential for explosive environments, as examples. For these contaminants, the cleanup concentrations are generally more stringent than strictly human health risk-based concentrations.

3.3 Tier 3

Tier 3 offers the opportunity to determine site-specific risk-based contaminant concentrations that are protective of human health and the environment. Tier 3 involves the substitution of site-specific parameters into the equations used to calculate Tier 2 cleanup values. Tier 3 evaluations can be a substantial increase in effort relative to Tier 2, and must be performed with KDHE/BER oversight, including the submittal of appropriate work plans to perform any necessary additional work. KDHE/BER will not authorize the performance of a Tier 3 analysis for contaminants of concern that are regulated by federal, state or local laws, such as the federal Safe Drinking Water Act which mandates MCLs for drinking water aquifers.

Default assumption parameters employed by KDHE/BER to calculate Tier 2 risk-based cleanup goals are included in Equations 5, 6, and 7. Parameters for which site-specific data may be substituted to perform a Tier 3 analysis are denoted with an asterisk. Data which may be necessary to complete a Tier 3 evaluation can include additional geological, geophysical or hydrological data, including items such as unsaturated zone physical and geological properties (vertical distribution profiling of fraction organic carbon, bulk density, total porosity, air-filled porosity, water-filled porosity, etc.), thickness of unsaturated zone, thickness of the saturated aquifer, aquifer transmissivity, hydraulic conductivity, gradient, infiltration rate, and longitudinal, lateral, and vertical dispersivities.

The following are examples of measures that may be undertaken as part of a Tier 3 analysis:

- The use of property-specific numerical soil or groundwater modeling to predict the effect of contaminant fate and transport mechanisms, including heterogeneous geological conditions (Any model used for a Tier 3 evaluation must be approved by the department project manager and must be a public domain model. In the event a proprietary model or any other model that KDHE/BER does not possess is used in a Tier 3 analysis, the department may request a copy of the model for review and approval.);
- Characterization of property sources and exposure pathways by using property assessment data to identify relevant sources, transport mechanisms, impacted media, and exposure pathways;
- Research to determine appropriate pesticide-specific standard application rates, followed by a comparison of site-specific pesticide contaminant levels to the modeled pesticide levels in the contaminated media based upon proper application;
- Identification of all potential receptors. Actual or potential receptors should be differentiated based on current and likely future land use, and upon the ability to place institutional controls at the property to eliminate potential exposure pathways;
- An evaluation of potential remedial actions that would reduce the human health or environmental risk to acceptable levels; and,
- Recalculation of health-based risk considering the site-specific speciation of metal contaminants. (For example, a site may have chromium contamination in the soil at levels greater than the Tier 2 values. However, if the contamination is predominantly trivalent chromium, which is much less toxic than hexavalent chromium, a Tier 3 analysis may result in a substantially higher soil clean-up value.)

In the event a site-specific Tier 3 analysis determines that Tier 2 cleanup goals are not protective of human health or the environment, the more stringent Tier 3 cleanup goals will become the site-specific cleanup goals for the site.

4.0 INDOOR AIR CONCENTRATIONS

VOC contamination may migrate from soil and/or groundwater into dwellings or other occupied structures. Appendix A of the RSK Manual contains the concentrations of contaminants in indoor air at or above which KDHE/BER may require actions to mitigate the potential risk to human health posed by inhalation of those contaminants. Indoor air concentrations are provided for the residential scenario for each VOC present in Appendix A. KDHE/BER provides a detailed discussion on sampling of indoor air at residences and interpretation of data in *Kansas Vapor Intrusion Guidance - Chemical Vapor Intrusion and Residential Indoor Air*, dated June 2007.

KDHE/BER calculated the indoor air values in Appendix A using Equations 8 and 9 for carcinogenic and non-carcinogenic contaminants, respectively. For each VOC contaminant, the default exposure factors (from Table 3) and toxicity data (Appendix C) used to establish indoor air concentrations were the same as those used for the calculations of soil and groundwater cleanup values. The indoor air concentrations in Appendix A for non-carcinogens are based upon an HI equal to 1; the concentrations for carcinogens are based upon a 1×10^{-5} risk level.

The indoor air concentrations in Appendix A are considered acceptable for only a single contaminant and do not consider potential cumulative adverse health effects of multiple chemicals. The concentrations also do not consider cumulative effects of exposure to the same contaminant through multiple pathways. Consultation with the KDHE/BER project manager is essential before applying the indoor air concentrations in Appendix A to a residence. If multiple contaminants are present in the home, or more than one exposure pathway exists, a Baseline Risk Assessment may be necessary to evaluate the health risk to exposed residents.

Some of the indoor air values provided in Appendix A fall within the range of what may be consistent with background concentrations of chemicals in a home. Therefore, it is possible chemicals may be present at levels above the Appendix A indoor air concentrations, but not caused by migration of contaminants from the subsurface. Background conditions should be evaluated during indoor air assessment activities, in consultation with the KDHE/BER project manager.

5.0 TOTAL PETROLEUM HYDROCARBONS

Total petroleum hydrocarbons (TPH) for the purpose of this section of the RSK Manual include all undifferentiated hydrocarbon compounds with carbon ranges C^5 through C^{35}, and containing various percentages of straight chain alkanes, branched chain alkanes, cycloalkanes, straight chain alkenes, branched chain alkenes, cycloalkenes, alkyl benzenes, naphtheno benzenes, alkyl naphthalenes and polynuclear aromatics. TPH cleanup concentrations in soil and groundwater, as related to the Tier 2 values in Appendix A, must be quantified by summing TPH using EPA SW-846 modified method 8015, laboratory analytical methods OA1 for gasoline range organics (GRO) and OA2 for diesel range organics (DRO), or other methods approved by KDHE/BER.

The use of Tier 2 values for TPH-GRO and TPH-DRO must be used in conjunction with the values for individual constituents in order to determine site cleanup goals. These constituents include but are not limited to benzene, toluene, ethylbenzene, total xylenes (BTEX), methyl-tert-butyl-ether (MTBE), ethylene dibromide (EDB), and 1,2-dichloroethane (1,2-DCA) for TPH-GRO and naphthalene, chrysene, pyrene, benzo[a]pyrene, and anthracene for TPH-DRO.

Considering that TPH detected at a site is commonly found as either GRO or DRO, KDHE has developed two separate Tier 2 risk-based concentrations based upon whether the TPH is entirely GRO or DRO. If the site has only one type of TPH (GRO or DRO), the risk-based cleanup concentrations for soil and groundwater are based upon their petroleum type as provided in Appendix A. For sites where both types of TPH are detected, the sum of the ratios of each hydrocarbon type must be calculated as follows:

$$\frac{X}{\text{GRO Tier 2 Value}} + \frac{Y}{\text{DRO Tier 2 Value}} = N$$

Where:

X = Detected GRO Concentration
Y = Detected DRO Concentration
N = Sum

For instance, where GRO and DRO are detected at 22 mg/kg and 1,000 mg/kg respectively, the hazard index would be determined as N = (22/220) + (1,000/2,000). Accordingly, N = 0.6, which is less than 1.0, therefore this scenario would be acceptable. Any N value greater than 1.0 would be considered an excessive risk and may require corrective action as determined by the KDHE/BER project manager.

KDHE/BER calculated the soil-to-groundwater pathway value for TPH-GRO by using the contaminant specific parameters of n-hexane. For TPH-DRO, the soil-to-groundwater pathway value is based upon the contaminant specific parameters of pyrene.

Non-residential TPH standards should not be used in the following situations unless approved by the KDHE/BER project manager:

- sites where contamination is caused by a responsible party that does not own or control the property;
- sites where an Environmental Use Control cannot be used to control future use of the property; or
- sites where contamination is located on the responsible party's property but is migrating or threatening to migrate to an adjacent property not under the ownership or control of the responsible party.

The current and future use of the property and the ownership of the property must be considered when determining the use of "Non-Residential" TPH Tier 2 levels. In most cases, the residential standards should be used as the target cleanup levels.

Independent of the TPH Tier 2 levels presented in Appendix A of this RSK Manual, all free product, including hydrocarbon saturated soil, must be addressed. KDHE has calculated soil saturation values for TPH GRO and TPH DRO of 3,300 mg/kg and 70,000 mg/kg, respectively. These values are estimates, and site-specific soil saturation values can vary based upon the nature of the product released at each site. However, these soil saturation values provide a default when a site-specific soil saturation value has not been calculated using Tier 3 methodology.

KDHE considers any apparent product on the groundwater surface to be a likely indicator of soil saturation, and therefore an indicator of the need to further evaluate the potential for free product and possible remediation at the site.

6.0 NITRATE, NITRITE, AND AMMONIA

Nitrate and ammonium are common soil contaminants of concern in Kansas related to agricultural fertilizer spills, animal wastes, septic systems, and a variety of other sources. These contaminants are treated differently from other Tier 2 contaminants as the soil cleanup guidelines provided below are not based on their potential toxicity to humans through exposure to contaminated soil, but on the potential for contamination in the soil to leach to groundwater. Nitrate and/or nitrite in groundwater pose significant threats of toxicity to human and animal infants, and cleanup of nitrate in groundwater can be an expensive, difficult, and time-consuming prospect. The soil cleanup guidelines provided below were developed by KDHE/BER in consultation with Kansas State University agronomy experts to provide non-site specific soil cleanup goals that are generally protective of groundwater and capable of sustaining vegetative growth.

Nitrate, nitrite, and ammonia or ammonium concentrations are typically reported "as nitrogen" or "as N." Analytical results expressed "as ammonia," "as nitrate," or "as nitrite" must be converted to "as N" based on the ratios of the molecular weight of nitrogen to the molecular weights of the compounds in question for comparison to the soil cleanup guidelines and groundwater standards provided below.

Soil Pathway:

- In areas where no vegetation is present (i.e., contamination in a gravel roadway, parking area, etc.) the following RSK standards apply:

  Upper 8 inches of soil - 85 milligrams/kilogram (mg/kg) total nitrate plus ammonia (N);

  Below 8 inches in depth - 40 mg/kg nitrate plus ammonia (N).

- In areas where vegetation is present (i.e., cultivated and cropped agricultural ground, pasture, lawn, etc.) the following RSK standards apply:

  Upper 24 inches of soil - 200 mg/kg total nitrate plus ammonia (N), or the maximum application rate recommended by Kansas State University for the particular crop;

  Below 24 inches in depth - 40 mg/kg nitrate plus ammonia (N).

Groundwater Pathway:

- The MCL for nitrate is 10.0 milligrams/liter (mg/L); the MCL for nitrite is 1.0 mg/L.

KDHE/BER will also consider the following site-specific conditions when determining the appropriate response action for a site contaminated by nitrate and/or ammonia.

1) If it is not possible to excavate soil to reach a 40 mg/kg total nitrate plus ammonia (N) level then the responsible party must determine the vertical extent of total nitrate plus ammonia (N) contamination through vertical profiling approved by KDHE/BER.

2) If groundwater is 50 feet or less in depth then groundwater monitoring wells may be requested by KDHE/BER in the area of contamination and hydraulically downgradient to the nitrate concentration in groundwater. Additional actions may be required:

a) If nitrate (N) in groundwater exceeds 20 mg/l then the responsible party may be required by KDHE/BER to install a remedial system to hydraulically contain and/or remove the contamination.

b) If nitrate (N) in groundwater is below the drinking water standard, or if the nitrate is shown to be from off-site sources, the monitoring points must be sampled in accordance with KDHE/BER identified sites reclassification criteria to monitor ground water quality. Please refer to KDHE/BER policy "BER-RS-024 - Reclassification Plan."

3) If groundwater depth exceeds 50 feet, the need for installation of monitoring wells will be determined by KDHE/BER on a case by case basis depending on groundwater usage, soil type, and soil concentration of nitrate plus ammonia (N). Depending on nitrate and nitrite concentrations in groundwater, additional actions may be required.

4) If vertical soil profiling indicates the presence of impervious bedrock (e.g., shale) isolating the nitrate/ammonia from groundwater, up to 200 mg/kg nitrate plus ammonia (N) can be left in place (as determined in consultation with the KDHE/BER project manager).

Excavation is commonly implemented as an appropriate response action to address soil contaminated with nitrate and/or ammonia. Nitrate and ammonia contaminated soil can be land applied on cultivated land at approved application rates. This approach requires the completion of the KDHE Land Application Work Plan and Agreement Form available from the KDHE/BER project manager.

Similar to the Tier 3 evaluations (see Section 3.3) for other contaminants, KDHE/BER will consider the use of site-specific information to modify nitrate cleanup goals. KDHE/BER will also consider cost/benefit analyses in the determination of cleanup goals.

7.0 TABLES, FORMULAS, AND EQUATIONS

TABLE 1

GROUNDWATER EXPOSURE FACTORS

ID	Description	Residents	Non-Residents
TR	Target cancer risk	1E-06, 1E-05, 1E-04	1E-06, 1E-05, 1E-04
THI	Target hazard index	1	1
BW	Body weight (kg)		
Bwa	Adult	70	70
BWc	Child (0-6 years)	15	NA
Irw	Daily water ingestion rate (L/day)		
Irwa	Adult	2	1
Irwc	Child	1	NA
INH	Inhalation rate (m3/day)		
INHa	Adult	20	20
INHc	Child	10	NA
VFw	Volatilization Factor (L/m3)	0.5	0.5
CF	Conversion Factor (L/cm3)	0.001	0.001
SA	Skin Surface Area (cm2)		
Saa	Adult	18,000	18,000
Sac	Child	6,600	NA
Kp	Skin permeability coefficient (cm/hr)	Chemical-specific	Chemical-specific
ET	Exposure Time (hours/day)	1	0.5
EF	Exposure Frequency (days/year)	350	250
ED	Exposure Duration (years)		
Edca	Cancer (adult)	30	25
Ednca	Noncancer (adult)	30	25
Edncc	Noncancer (Child)	6	NA
AT	Averaging Time		
ATca	Cancer (adult)	70	70
Atnca	Noncancer (adult)	30	25
Atncc	Noncancer (child)	6	NA
SFo	Slope Factor, Oral (carcinogens)	Chemical-specific	Chemical-specific
IUR	Inhalation Unit Risk (carcinogens)	Chemical-specific	Chemical-specific
RfDo	Reference Dose, Oral	Chemical-specific	Chemical-specific
RfC	Reference Concentration	Chemical-specific	Chemical-specific

Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A) EPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors".

Risk Assessment Guidance for Superfund, Part B: Development of Risk-based Preliminary Remediation Goals.

Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, EPA, 2004.

EQUATION 1 - GROUNDWATER / CARCINOGENS

Ing. & Derm. (mg/L) = (ingestion and dermal exposure)

$$\frac{TR \times BW \times AT \times 365 \text{ days / year}}{EF \times ED \left[(IR_w \times SF_o) + (ET \times CF \times SA \times Kp \times SF_o)\right]}$$

Inh. (mg/L) = (inhalation exposure, for only VOCs)

$$\frac{TR \times AT \times 365 \text{ days / year}}{EF \times ED \times IUR \times 1000ug/mg \times VF_w}$$

Tier 2 value (mg/L) =

$$\frac{1}{\frac{1}{\text{Ing. \& Derm.}} + \frac{1}{\text{Inh.}}}$$

EQUATION 2 - GROUNDWATER / NON-CARCINOGENS

Ing. & Derm. (mg/L) = (ingestion and dermal exposure)

$$\frac{THI \times BW \times AT \times 365 \text{ days / year}}{EF \times ED \times \left[(IR_w \times 1/RfD_o) + (ET \times CF \times SA \times Kp \times 1/RfD_o)\right]}$$

Inh. (mg/L) = (inhalation exposure, for only VOCs)

$$\frac{THI \times AT \times 365 \text{ days / year}}{EF \times ED \times 1/RfC \times VF_w}$$

Tier 2 value (mg/L) =

$$\frac{1}{\frac{1}{\text{Ing. \& Derm.}} + \frac{1}{\text{Inh.}}}$$

TABLE 2

SOIL EXPOSURE FACTORS

ID	Description	Residents	Non-Residents
TR	Target cancer risk	1E-06, 1E-05, 1E-04	1E-06, 1E-05, 1E-04
THI	Target hazard index	1	1
BW	Body weight (kg)		
Bwa	Adult	70	70
BWc	Child (0-6 years)	15	NA
INGs	Soil ingestion rate (mg/day)		
INGsa	Adult	100	50
INGsc	Child	200	NA
INH	Soil inhalation rate (m3/day)		
INHa	Adult	20	20
INHc	Child	10	NA
VFs	Soil Volatilization Factor (m3/kg)	Chemical-specific	Chemical-specific
CF	Conversion Factor (kg/mg)	1E-06	1E-06
PEF	Particulate Emission Factor (m3/kg)	1.18E+09	1.18E+09
SA	Skin Surface Area (cm2/day)		
Saa	Adult	5700	3300
Sac	Child	2800	NA
ABS	Absorption Factor (fraction)	0.1	0.1
AF	Adherence Factor (mg/cm2)	0.2	0.2
EF	Exposure Frequency (days/year)	350	250
ED	Exposure Duration (years)		
Edca	Cancer (adult)	30	25
Ednca	Noncancer (adult)	30	25
Edncc	Noncancer (child)	6	NA
AT	Averaging Time		
Atca	Cancer (adult)	70	70
Atnca	Noncancer (adult)	30	25
Atncc	Noncancer (child)	6	NA
SFo	Slope Factor, Oral (carcinogens)	Chemical-specific	Chemical-specific
IUR	Inhalation Unit Risk	Chemical-specific	Chemical-specific
RfDo	Reference Dose, Oral	Chemical-specific	Chemical-specific
RfC	Reference Concentration, Inhalation	Chemical-specific	Chemical-specific

See references in Table 1

EQUATION 3 - SOIL / CARCINOGENS

$$\text{Ing. \& Derm. (mg/kg)} = \frac{\text{TR x BW x AT x 365 days / year}}{\text{EF x ED } [(ING_s \text{ x CF x } SF_o) + (SF_o \text{ x CF x SA x AF x ABS})]}$$

(ingestion and dermal exposure)

$$\text{Inh. (mg/kg)} = \frac{\text{TR x AT x 365 days / year}}{\text{EF x ED x IUR x 1000ug/mg x } [(1/VF_s) + (1/PEF)]}$$

(inhalation exposure)

$$\text{Tier 2 value (mg/kg)} = \frac{1}{\frac{1}{\text{Ing. \& Derm.}} + \frac{1}{\text{Inh.}}}$$

EQUATION 4 - SOIL / NON-CARCINOGENS

$$\text{Ing. \& Derm. (mg/kg)} = \frac{\text{THI x BW x AT x 365 days / year}}{\text{EF x ED x } [(ING_s \text{ x CF x } 1/RfD_o) + (1/RfD_o \text{ x CF x SA x AF x ABS})]}$$

(ingestion and dermal exposure)

$$\text{Inh. (mg/kg)} = \frac{\text{THI x AT x 365 days / year}}{\text{EF x ED x (1/RfC) x } [(1/VF_{s)} + (1/PEF)]}$$

(inhalation exposure)

$$\text{Tier 2 value (mg/kg)} = \frac{1}{\frac{1}{\text{Ing. \& Derm.}} + \frac{1}{\text{Inh.}}}$$

EQUATION 5 VOLATILIZATION FACTOR EQUATION AND PARAMETERS

$$VF\ (m^3/kg) = \frac{Q}{C} * \frac{[(3.14)(D_A)(T)]^{1/2}}{2\ x\ \rho_b x D_A} x10^{-4}\ (m^2/cm^2)$$

$$\text{where } D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Chemical-Specific Parameters	**Default**
VF = Volatilization factor (m^3/kg)	--
D_A = Apparent diffusivity (cm^2/s)	--
Q/C = Inverse of the mean concentration at the center of square source (g/m^2-s per kg/m^3)	81.64
T = Exposure interval (seconds)	9.5 E+08
ρ_b = Dry soil bulk density (g/cm^3)	1.5 *
θ_a= Air filled soil porosity (Lair/Lsoil)	0.28 *
n = Total soil porosity (Lpore/Lsoil)	0.43 *
θ_w= Water filled soil porosity (Lwater/Lsoil)	0.15 *
ρ_s = Soil particle density (g/cm^3)	2.65 *
Di = Diffusivity in air (cm^2/s)	Chemical-specific
RG = Universal Gas Constant (atm-m3/mole-K)	0.000082
TEMP = Temperature (K)	293
H = Henry's Law constant (atm-m^3/mol)	Chemical-specific
H' = Dimensionless Henry's Law constant	H/(RG x TEMP), chemical-specific
D_w = Diffusivity in water (cm^2/s)	Chemical-specific
Kd = Soil-water partition coefficient (cm3/g) = Kocfoc	Chemical-specific
Koc = Soil organic carbon-water partition coefficient (cm3/g)	Chemical-specific
Foc = Fraction organic carbon in soil (g/g)	0.01 *

***** *Asterisk notes the chemical-specific parameters that may be modified in a property-specific Tier 3 analyses.*

EQUATION 6 SOIL SATURATION EQUATION AND PARAMETERS

$$C_{sat} = \frac{S}{P_b}(K_d\ P_b + \theta_w + H'\theta_a)$$

Parameter Definition (units)	Default
Csat = Soil saturation concentration (mg/kg)	--
S = Solubility in water (mg/L-water)	chemical-specific
ρb = Dry soil bulk density (kg/L)	1.5 *
Kd = Soil-water partition coefficient (L/kg)	Koc × foc (chemical-specific)
Koc = Soil organic carbon/water partition coefficient (L/kg)	chemical-specific
foc = Fraction organic carbon in soil (g/g)	0.01 *
θw = Water-filled soil porosity (Lwater/Lsoil)	0.15 *
H' = Dimensionless Henry's law constant	Chemical-specific
θa = Air-filled soil porosity (Lair/Lsoil)	0.28 *
n = Total soil porosity (Lpore/Lsoil)	0.43 *
ρs = Soil particle density (kg/L)	2.65 *

* *Asterisk notes the physical and chemical-specific parameters that may be modified in a property-specific Tier 3 analysis.*

EQUATION 7 SOIL TO GROUNDWATER MIGRATION PATHWAY EQUATION

$$C_t = C_w \left\langle (K_d) + \frac{\theta_w + \theta_a H'}{\rho_b} \right\rangle$$

SOIL TO GROUND WATER PROTECTION PARAMETERS

Parameter Definition (units)	**Default**
Ct = Screening level in soil (mg/kg)	--
Cw = Target soil leachate concentration (mg/l)	(non-zero MCLG, MCL, or RBC) x 20 DAF
Koc = Soil organic carbon/water partition coefficient (l/kg)	Chemical-specific (see Appendix B)
foc = Fraction organic carbon in soil (g/g)	0.01 *
Kd = Soil-water partition coefficient (L/kg)	Chemical specific for inorganic contaminants; Koc × foc for organic contaminants
θw = Water-filled soil porosity (Lwater/Lsoil)	0.30 *
θa = Air-filled soil porosity (Lair/Lsoil)	0.13 *
n = Total soil porosity (Lpore/Lsoil)	0.43 *
ρb = Dry soil bulk density (kg/L)	1.5 *
ρs = Soil particle density (kg/L)	2.65 *
RG = Universal gas constant (atm-m3/mole-K)	0.000082
TEMP = Temperature (K)	293
H' = Dimensionless Henry's Law constant	H/(RG x TEMP), chemical-specific
H = Henry's Law constant (atm-m3/mol)	Chemical-specific

***** *Asterisk notes the physical and chemical-specific parameters that may be modified in a property-specific Tier 3 analysis.*

EQUATION 8 INDOOR AIR / CARCINOGENS

$$\text{Tier 2 value } (\mu g/m^3) = \frac{TR \times AT \times 365 \text{ days / year}}{EF \times ED \times IUR}$$

EQUATION 9 INDOOR AIR / NON-CARCINOGENS

$$\text{Tier 2 value } (\mu g/m^3) = \frac{THI \times AT \times 365 \text{ days/year} \times 1000\ \mu g/mg}{EF \times ED \times (1/RfC)}$$

TABLE 3
INDOOR AIR EXPOSURE FACTORS

ID	Description	Value
TR	Target cancer risk	1E-06, 1E-05, 1E-04
THI	Target hazard index	1
EF	Exposure frequency (days/year)	350
ED	Exposure duration (years)	
	Cancer (adult)	30
	Non-cancer (adult)	30
	Non-cancer (child)	6
AT	Averaging time (years)	
	Cancer (adult)	70
	Non-cancer (adult)	30
	Non-cancer (child)	6
IUR	Inhalation Unit Risk factor	Chemical-specific
RfC	Reference concentration	Chemical-specific

See references in Table 1

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APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

		Residential Scenario							Non-residential Scenario					Soil
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw	Saturation
Contaminant	CAS No.	mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg	mg/kg
Acenaphthene	83-32-9	3420	ns	0.253	n	255	219	n	30600	ns	0.521	n	526	196
Acetochlor	34256-82-1	1220	ns	0.303	n	19.3			17600	ns	1.96	n	125	688
Acetone	67-64-1	50300	n	11.5	n	51.6	32300	n	406000	ns	45.5	n	204	124000
Acetophenone	98-86-2	5200	ns	0.494	n	7.1	365	n	31300	ns	0.926	n	13.3	3790
Acrolein	107-02-8	0.192	n	4.15E-05	n	0.000175	0.0209	n	0.27	n	5.83E-05	n	0.000246	23500
Acrylamide	79-06-1	15.9	c	0.0017	c	0.00874			49.3	c	0.00571	c	0.0294	61200
Acrylonitrile	107-13-1	3.18	c	0.000491	c	0.0028	0.358	c	5.93	c	0.000978	c	0.00559	13900
Alachlor (Lasso)	15972-60-8	142	c	0.002	m	0.133			440	c	0.002	m	0.133	774
Aldicarb (Temik)	116-06-3	61.1	n	0.0156	n	0.139			881	n	0.102	n	0.906	2090
Aldrin	309-00-2	0.468	c	4.95E-05	c	0.812			1.45	c	0.000166	c	2.73	13.9
Anthracene	120-12-7	18000	ns	1.15	n	3770	1100	n	221000	ns	2.5	n	8180	7.1
Antimony	7440-36-0	31.3	n	0.006	m				817	n	0.006	m		
Arsenic	7440-38-2	11.3	c	0.01	m				38	c	0.01	m		
Atrazine	1912-24-9	34.6	c	0.003	m	0.147			107	cs	0.003	m	0.147	81.4
Barium	7440-39-3	15300	n	2	m				277000	n	2	m		
Bentazon	25057-89-0	1830	ns	0.462	n	2.77			26400	ns	3	n	18	100
Benzene	71-43-2	15.9	c	0.005	m	0.168	3.12	c	28.2	c	0.005	m	0.168	2870
Benzidine	92-87-5	0.0346	c	3.67E-06	c	0.000887			0.107	c	1.23E-05	c	0.00298	3860
Benzo(a)anthracene	56-55-3	10.9	c	0.000223	c	7.89			33.8	cs	0.00075	c	26.5	16.6
Benzo(b)fluoranthene	205-99-2	10.9	cs	0.00016	c	19.2			33.8	cs	0.000537	c	64.4	8.99
Benzo(k)fluoranthene	207-08-9	109	cs	0.00162	c	190			338	cs	0.00543	c	638	4.7
Benzo(a)pyrene	50-32-8	1.09	c	0.0002	m	23.5			3.38	c	0.0002	m	23.5	9.52
Benzyl Chloride	100-44-7	14.6	c	0.000817	c	0.0762	0.497	c	28.5	c	0.00151	c	0.14	2400
Beryllium	7440-41-7	155	n	0.004	m				3650	n	0.004	m		
Bis(2-chloroethyl)ether	111-44-4	2.92	c	0.000124	c	0.00129	0.0737	c	6.01	c	0.000226	c	0.00236	7260
Bis(chloromethyl)ether	542-88-1	0.00102	c	6.52E-07	c	4.07E-06	0.000392	c	0.00174	c	1.20E-06	c	7.48E-06	5070
Bis(2-ethylhexyl)phthalate	117-81-7	569	cs	0.006	m	144			1760	cs	0.006	m	144	323
Bromacil	314-40-9	6110	ns	1.55	n	26.9			88100	ns	10.1	n	175	79.3
Bromodichloromethane	75-27-4	3.93	c	0.08	m	0.841	0.658	c	6.69	c	0.08	m	0.841	1320
Bromoform	75-25-2	1010	c	0.08	m	0.832			3120	cs	0.08	m	0.832	1310
Bromomethane	74-83-9	9.39	n	0.007	n	0.05	5.21	n	14.6	n	0.0132	n	0.0947	4380
1,3-Butadiene	106-99-0	0.697	c	0.000193	c	0.0033	0.811	c	1.36	c	0.000579	c	0.00992	776
Butyl Benzyl Phthalate	85-68-7	4190	cs	0.333	c	478			13000	cs	1.12	c	1610	193
Butylate	2008-41-5	3060	ns	0.576	n	46.8			44000	ns	3.44	n	279	178
n-Butylbenzene	104-51-8	285	ns	0.0338	n	10.2	36.5	n	687	ns	0.0785	n	23.6	252

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

Contaminant	CAS No.	Residential Scenario							Non-residential Scenario					Soil Saturation
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw	
		mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg	mg/kg
sec-Butylbenzene	135-98-8	276	n	0.0305	n	8.27	36.5	n	654	ns	0.0745	n	20.2	381
Cadmium	7440-43-9	39	n	0.005	m				965	n	0.005	m		
Caprolactam	105-60-2	30600	n	7.77	n	69.2			440000	n	50.6	n	451	266000
Captan	133-06-2	3460	cs	0.366	c	19.9			10700	cs	1.23	c	67	13.4
Carbaryl (Sevin)	63-25-2	6110	ns	1.52	n	114			88100	ns	9.84	n	737	401
Carbazole	86-74-8	398	c	0.0287	c	52.7			1230	c	0.0965	c	177	1300
Carbofuran (Furadan)	1563-66-2	306	n	0.04	m	0.922			4400	ns	0.04	m	0.922	337
Carbon Disulfide	75-15-0	1020	ns	0.716	n	6.71	730	n	1680	ns	1.66	n	15.6	923
Carbon Tetrachloride	56-23-5	8.44	c	0.005	m	0.0734	4.06	n	14.7	c	0.005	m	0.0734	590
Chlordane	12789-03-6	22.7	cs	0.002	m	13.5			70.5	cs	0.002	m	13.5	18.9
Chlordecone (Kepone)	143-50-0	0.796	c	7.76E-05	c	0.272			2.47	c	0.000261	c	0.913	473
Chlorobenzene	108-90-7	380	n	0.1	m	5.1	52.1	n	740	n	0.1	m	5.1	1230
Chlorodifluoromethane	75-45-6	65400	ns	70.7	n	941	52100	n	98300	ns	132	n	1760	2040
Chloroform	67-66-3	4.22	c	0.08	m	0.85	1.06	c	7.14	c	0.08	m	0.85	3550
Chloromethane	74-87-3	146	n	0.127	n	0.924	93.9	n	223	n	0.238	n	1.73	1590
beta-Chloronaphthalene	91-58-7	4350	ns	0.344	n	172	292	n	30900	ns	0.7	n	350	291
o-Chlorotoluene	95-49-8	542	n	0.0889	n	7.18	73	n	1270	n	0.178	n	14.3	1480
Chlorpyrifos (Lorsban/Dursban)	2921-88-2	183	ns	0.0385	n	56.2			2640	ns	0.236	n	344	81.7
Chromium (total)	18540-29-9	33.6	c	0.1	m				111	c	0.1	m		
Chrysene	218-01-9	1090	cs	0.0223	c	805			3380	cs	0.075	c	2710	3.61
Cobalt	7440-48-4	23.4	n	0.00468	n				579	n	0.0306	n		
Copper	7440-50-8	3130	n	1.3	m				81700	n	1.3	m		
Cumene	98-82-8	2540	ns	0.451	n	65.1	417	n	5680	ns	0.968	n	140	439
Cyanazine (Bladex)	21725-46-2	9.47	c	0.000995	c	0.0307			29.4	c	0.00334	c	0.103	245
Cyanide	57-12-5	1560	n	0.2	m				40900	n	0.2	m		
Dacthal	1861-32-1	611	ns	0.142	n	15.1			8810	ns	0.9	n	95.6	2.61
DDD	72-54-8	33.2	c	0.00135	c	31.8			103	c	0.00455	c	107	106
DDE	72-55-9	23.4	c	0.00103	c	24.1			72.5	cs	0.00345	c	81.1	47
DDT	50-29-3	23.4	cs	0.00073	c	24.6			72.5	cs	0.00245	c	82.8	9.27
Diazinon	333-41-5	42.8	n	0.0102	n	6.26			617	n	0.0654	n	40	1220
Dibenzo(a,h)anthracene	53-70-3	1.09	c	8.05E-06	c	3.08			3.38	c	2.70E-05	c	10.3	47.6
Dibenzofuran	132-64-9	58.2	n	0.00413	n	7.59	3.65	n	579	ns	0.0086	n	15.8	284
1,4-Dibromobenzene	106-37-6	611	ns	0.135	n	10.7			8810	ns	0.837	n	66.3	77.2
Dibromochloromethane	124-48-1	94.7	c	0.08	m	0.834			294	c	0.08	m	0.834	1150
1,2-Dibromo-3-chloropropane	96-12-8	9.93	c	0.0002	m	0.00543			30.7	c	0.0002	m	0.00543	1550

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

		Residential Scenario							Non-residential Scenario					Soil
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw	Saturation
Contaminant	CAS No.	mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg	mg/kg
Dibutyl Phthalate	84-74-2	6110	ns	1.35	n	318			88100	ns	8.4	n	1980	131
Dicamba	1918-00-9	1830	n	0.461	n	4.52			26400	ns	2.99	n	29.4	3240
1,2-Dichlorobenzene	95-50-1	2340	ns	0.6	m	48.4	209	n	5340	ns	0.6	m	48.4	615
1,4-Dichlorobenzene	106-46-7	37.5	c	0.075	m	5.94	2.21	c	63.7	c	0.075	m	5.94	315
Dichlorodifluoromethane	75-71-8	227	n	0.366	n	13.5	209	n	323	n	0.567	n	21	883
1,1-Dichloroethane	75-34-3	46.8	c	0.025	c	0.269	15.2	c	79.9	c	0.0461	c	0.496	2320
1,2-Dichloroethane	107-06-2	6.27	c	0.005	m	0.06	0.936	c	10.9	c	0.005	m	0.06	4340
1,1-Dichloroethylene	75-35-4	313	n	0.007	m	0.0859	209	n	484	n	0.007	m	0.0859	1510
cis-1,2-Dichloroethylene	156-59-2	115	n	0.07	m	0.855	36.5	n	194	n	0.07	m	0.855	3380
trans-1,2-Dichloroethylene	156-60-5	202	n	0.1	m	1.22	62.6	n	333	n	0.1	m	1.22	2390
2,4-Dichlorophenol	120-83-2	183	n	0.0412	n	4.22			2640	n	0.258	n	26.4	22600
4-(2,4-Dichlorophenoxy)butyric acid	94-82-6	489	ns	0.115	n	2.71			7050	ns	0.727	n	17.2	49.9
2,4-Dichlorophenoxyacetic acid	94-75-7	611	ns	0.07	m	0.695			8810	ns	0.07	m	0.695	268
1,2-Dichloropropane	78-87-5	12.9	c	0.005	m	0.0817	2.43	c	22.3	c	0.005	m	0.0817	2040
1,3-Dichloropropene	542-75-6	23.3	c	0.0049	c	0.0916	6.08	c	45.2	c	0.0117	c	0.219	2380
Dichlorvos	62-73-7	27.4	c	0.00291	c	0.0431			85.1	c	0.00979	c	0.145	5120
Dieldrin	60-57-1	0.497	c	4.80E-05	c	0.193			1.54	c	0.000161	c	0.649	39.2
Diethyl Phthalate	84-66-2	48900	ns	12.2	n	305			705000	ns	79	n	1970	1240
2,4-Dimethylphenol	105-67-9	1220	n	0.292	n	29.9			17600	n	1.86	n	190	39500
Dimethylphthalate	131-11-3	611000	ns	155	n	1600			8810000	ns	1010	n	10400	3100
2,4-Dinitrophenol	51-28-5	122	n	0.031	n	2.98			1760	n	0.202	n	19.4	13100
2,4-Dinitrotoluene	121-14-2	25.7	c	0.00267	c	0.318			79.6	c	0.00898	c	1.07	1170
2,6-Dinitrotoluene	606-20-2	61.1	n	0.0154	n	1.87			881	n	0.1	n	12.2	900
Di-n-octyl Phthalate	117-84-0	1220	ns	0.0184	n	518			17600	ns	0.0894	n	2520	0.649
1,4-Dioxane	123-91-1	723	c	0.0772	c	0.349			2240	c	0.259	c	1.17	126000
Dioxin (2,3,7,8-TCDD)	1746-01-6	6.11E-05	c	3.00E-08	m	0.00149			0.00019	c	3.00E-08	m	0.00149	0.498
Diphenylamine	122-39-4	1530	ns	0.314	n	53.1			22000	ns	1.91	n	324	443
Diuron	330-54-1	122	ns	0.0304	n	0.784			1760	ns	0.196	n	5.07	50
Endosulfan	115-29-7	367	ns	0.0921	n	125			5290	ns	0.598	n	811	22
Endrin	72-20-8	18.3	n	0.002	m	8.04			264	ns	0.002	m	8.04	50.3
Ethyl Chloride	75-00-3	18200	ns	14	n	128	10400	n	28100	ns	26.4	n	241	2690
s-Ethyl Dipropylthiocarbamate (EPTC)	759-94-4	1410	ns	0.12	n	4.41	91.3	n	11700	ns	0.229	n	8.43	653
Ethylbenzene	100-41-4	82	c	0.7	m	65.6	9.73	c	145	c	0.7	m	65.6	781
Ethylene Dibromide	106-93-4	0.483	c	5.00E-05	m	0.000598	0.0406	c	0.859	c	5.00E-05	m	0.000598	1960
Ethylene Glycol	107-21-1	122000	ns	31.3	n	131			1760000	ns	204	n	858	110000

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		Residential Scenario							Non-residential Scenario					Soil
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw	Saturation
Contaminant	CAS No.	mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg	mg/kg
Fluoranthene	206-44-0	2440	ns	0.255	n	2830			35200	ns	1.37	n	15200	144
Fluorene	86-73-7	2360	ns	0.162	n	297	146	n	25900	ns	0.341	n	626	155
Fonofos (Dyfonate)	944-22-9	122	n	0.0266	n	4.65			1760	ns	0.164	n	28.8	136
Formaldehyde	50-00-0	175	c	0.0184	c	0.0774			542	c	0.0619	c	0.26	44000
Furan	110-00-9	12.4	n	0.00493	n	0.1	3.65	n	21.3	n	0.00925	n	0.189	9410
Glyphosate (Roundup)	1071-83-6	6110	ns	0.7	m	2.94			88100	ns	0.7	m	2.94	1160
Heptachlor	76-44-8	1.77	c	0.0004	m	3.3			5.48	c	0.0004	m	3.3	74.3
Heptachlor Epoxide	1024-57-3	0.794	n	0.0002	m	0.405			2.71	c	0.0002	m	0.405	20.2
Hexachlorobenzene	118-74-1	4.97	cs	0.001	m	1.24			15.4	cs	0.001	m	1.24	0.385
Hexachlorobutadiene	87-68-3	61.1	ns	0.00632	c	1.1			316	ns	0.0212	c	3.69	27.6
gamma-Hexachlorocyclohexane (Lindane)	58-89-9	7.24	c	0.0002	m	0.113			22.4	c	0.0002	m	0.113	206
Hexachlorocyclopentadiene	77-47-4	366	ns	0.05	m	14.3			5210	ns	0.05	m	14.3	25.8
Hexachloroethane	67-72-1	61.1	n	0.0131	n	0.57			881	ns	0.0805	n	3.51	105
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	72.4	cs	0.00772	c	0.168			224	cs	0.0259	c	0.566	59.1
n-Hexane	110-54-3	656	ns	0.316	n	50.1	730	n	1100	ns	1.06	n	167	145
Hydrazine	302-01-2	5.67	c	0.000134	c				19	c	0.000876	c		
Hydrazine Sulfate	10034-93-2	5.67	c	0.000284	c				19	c	0.000953	c		
Indeno(1,2,3-cd)pyrene	193-39-5	10.9	cs	0.000117	c	45.5			33.8	cs	0.000392	c	153	3.71
Lead	7439-92-1	400	k	0.015	m				1000	k	0.015	m		
Malathion	121-75-5	1220	ns	0.311	n	3.19			17600	ns	2.03	n	20.8	59
Manganese	7439-96-5	9300	n	0.05	M				66200	n	0.05	M		
Mercury	7439-97-6	2	k	0.002	m				20	k	0.002	m		
Methoxychlor	72-43-5	306	ns	0.04	m	215			4400	ns	0.04	m	215	26.9
Methyl Ethyl Ketone	78-93-3	26000	n	4.92	n	24.2	5210	n	101000	ns	11.8	n	57.8	32500
Methyl Isobutyl Ketone	108-10-1	4450	ns	1.02	n	6.69	3130	n	34800	ns	4.17	n	27.2	4310
Methyl tert-Butyl Ether	1634-04-4	585	c	0.133	c	0.848	93.6	c	1050	c	0.262	c	1.66	11200
Methylene Chloride	75-09-2	149	c	0.005	m	0.0429	51.8	c	267	c	0.005	m	0.0429	4440
2-Methylnaphthalene	91-57-6	209	n	0.0167	n	8.34	14.6	n	1280	ns	0.0346	n	17.3	612
2-Methylphenol	95-48-7	3060	n	0.744	n	48.6			44000	n	4.78	n	312	82000
3-Methylphenol	108-39-4	3060	n	0.744	n	47.7			44000	n	4.77	n	306	70500
4-Methylphenol	106-44-5	306	n	0.0744	n	4.77			4410	n	0.478	n	30.6	66700
Metolachlor (Dual)	51218-45-2	9170	ns	2.3	n	233			132000	ns	14.9	n	1510	2640
Metribuzin (Sencor)	21087-64-9	1530	ns	0.388	n	5.67			22000	ns	2.53	n	36.9	663
Naphthalene	91-20-3	30.5	c	0.00111	c	0.349	0.716	c	64.7	c	0.00211	c	0.659	482
Nickel	7440-02-0	1540	n	0.312	n				32400	n	2.04	n		

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

		Residential Scenario							Non-residential Scenario						Soil
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw		Saturation
Contaminant	CAS No.	mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg		mg/kg
Nitrobenzene	98-95-3	32.2	c	0.00101	c	0.0496	0.608	c	72.9	c	0.00185	c	0.0912		4940
Nitrofurazone	59-87-0	6.12	c	0.000654	c	0.0484			19	c	0.0022	c	0.163		755
Nitroguanidine	556-88-7	6110	ns	1.56	n	12.7			88100	ns	10.2	n	83		1350
2-Nitropropane	79-46-9	0.151	c	1.50E-05	c	0.000153	0.00901	c	0.276	c	2.75E-05	c	0.00028		6950
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0	3060	ns	0.782	n	86.3			44000	ns	5.11	n	564		27.1
Oxamyl	23135-22-0	1530	n	0.2	m	1.2			22000	n	0.2	m	1.2		56000
Paraquat	1910-42-5	275	n	0.0704	n	95.7			3960	n	0.46	n	625		47500000
Parathion	56-38-2	367	ns	0.0864	n	42.2			5290	ns	0.549	n	268		268
Pendimethalin (Prowl)	40487-42-1	2440	ns	0.356	n	401			35200	ns	2.01	n	2260		16.9
Pentachlorophenol	87-86-5	66.3	c	0.001	m	0.996			206	c	0.001	m	0.996		696
Perchlorate	7790-98-9	54.7	n	0.0109	n	0.0435			1430	n	0.0709	n	0.284		
Permethrin (Ambush)	52645-53-1	3060	ns	0.33	n	7830			44000	ns	1.78	n	42300		7.13
Phenol	108-95-2	18300	n	4.56	n	189			264000	ns	29.5	n	1220		163000
Phenylphenol	90-43-7	4190	c	0.381	c	514			13000	c	1.28	c	1730		47100
Phosphine	7803-51-2	23.5	n	0.00466	n				612	n	0.0304	n			
Picloram (Tordon)	1918-02-1	4280	ns	0.5	m	5.88			61700	ns	0.5	m	5.88		210
Profluralin	26399-36-0	367	ns	0.0589	n	360			5290	ns	0.339	n	2070		30.5
Prometon	1610-18-0	917	n	0.222	n	7			13200	ns	1.43	n	44.9		1110
Propachlor (Ramrod)	1918-16-7	794	n	0.2	n	8.96			11500	ns	1.3	n	58.2		1240
Propazine (Miloguard)	139-40-2	1220	ns	0.299	n	21.8			17600	ns	1.92	n	140		30.5
n-Propylbenzene	103-65-1	4070	ns	0.66	n	110	1040	n	14300	ns	1.91	n	320		434
Pyrene	129-00-0	1830	ns	0.202	n	2190			26400	ns	1.09	n	11900		73.4
Pyridine	110-86-1	51.5	n	0.00496	n	0.091	3.65	n	301	n	0.00928	n	0.17		817000
Selenium	7782-49-2	391	n	0.05	m				10200	n	0.05	m			
Silver	7440-22-4	391	n	0.0779	n				10200	n	0.508	n			
Simazine (Princap)	122-34-9	66.3	cs	0.004	m	0.133			206	cs	0.004	m	0.133		9.7
Styrene	100-42-5	7020	ns	0.1	m	9.34	1040	n	20400	ns	0.1	m	9.34		1420
Terbacil (Sinbar)	5902-51-2	794	ns	0.201	n	2.82			11500	ns	1.31	n	18.3		427
Terbufos (Counter)	13071-79-9	1.53	n	0.000316	n	0.0645			22	n	0.00193	n	0.394		51.2
Tert-butyl Alcohol	75-65-0	2410	c	0.256	c	1.13			7470	c	0.859	c	3.8		18300
1,1,1,2-Tetrachloroethane	630-20-6	27.8	c	0.00535	c	0.114	3.29	c	48.8	c	0.00991	c	0.212		1050
1,1,2,2-Tetrachloroethane	79-34-5	8.21	c	0.000694	c	0.016	0.42	c	15.2	c	0.00128	c	0.0294		2980
Tetrachloroethylene	127-18-4	7.54	c	0.005	m	0.121	4.12	c	16.5	c	0.005	m	0.121		244
2,3,4,6-Tetrachlorophenol	58-90-2	1830	ns	0.32	n	191			26400	ns	1.87	n	1120		685
Tetryl	479-45-8	244	n	0.0624	n	57.7			3520	ns	0.407	n	377		3420

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

Contaminant	CAS No.	Residential Scenario							Non-residential Scenario					Soil Saturation
		Soil Pathway		Groundwater		Soil-to-Gw	Indoor air		Soil Pathway		Groundwater		Soil-to-Gw	
		mg/kg		mg/L		mg/kg	ug/m^3		mg/kg		mg/L		mg/kg	mg/kg
Toluene	108-88-3	4320	ns	1	m	51.2	5210	n	29800	ns	1	m	51.2	1310
Total Petroleum Hydrocarbons (GRO)		220	k	0.5	k	79.3			450	k	0.5	k	79.3	3300
Total Petroleum Hydrocarbons (DRO)		2000	k	0.5	k	5440			20000	k	0.72	k	7830	70000
Toxaphene	8001-35-2	7.24	cs	0.003	m	46.3			22.4	cs	0.003	m	46.3	5.38
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	13800	ns	3.94	n	321	31300	n	60000	ns	20.3	n	1660	1050
1,2,4-Trichlorobenzene	120-82-1	89.2	n	0.07	m	19.3	2.09	n	144	n	0.07	m	19.3	670
1,1,1-Trichloroethane	71-55-6	11800	ns	0.2	m	2.8	5210	n	18100	ns	0.2	m	2.8	864
1,1,2-Trichloroethane	79-00-5	15.6	c	0.005	m	0.081	1.52	c	27.6	c	0.005	m	0.081	3270
Trichloroethylene	79-01-6	41	c	0.005	m	0.0842	12.2	c	69.8	c	0.005	m	0.0842	1000
Trichlorofluoromethane	75-69-4	1000	n	1.09	n	21.5	730	n	1470	ns	1.9	n	37.5	1410
2,4,5-Trichlorophenol	95-95-4	6110	n	1.26	n	454			88100	ns	7.71	n	2770	21400
2,4,6-Trichlorophenol	88-06-2	61.1	n	0.0127	n	4.57			881	n	0.0777	n	27.9	14300
2,4,5-Trichlorophenoxyacetic Acid	93-76-5	611	ns	0.148	n	3.75			8810	ns	0.944	n	24	325
2,4,5-Trichlorophenoxypropionic acid	93-72-1	489	ns	0.05	m	1.95			7050	ns	0.05	m	1.95	132
1,2,3-Trichloropropane	96-18-4	0.0576	c	4.68E-06	c	0.000127	0.00284	c	0.107	c	8.62E-06	c	0.000234	2210
Trifluralin (Treflan)	1582-09-8	458	ns	0.0668	c	219			3200	ns	0.225	c	737	30.2
1,2,4-Trimethylbenzene	95-63-6	54	n	0.00844	n	1.07	7.3	n	126	n	0.0174	n	2.21	359
1,3,5-Trimethylbenzene	108-67-8	243	n	0.044	n	5.51	36.5	n	530	ns	0.0884	n	11.1	298
2,4,6-Trinitrotoluene	118-96-7	30.6	n	0.00777	n	4.4			440	n	0.0507	n	28.7	3250
Vinyl Acetate	108-05-4	1260	n	0.406	n	2.09	209	n	1800	n	0.581	n	2.99	3200
Vinyl Chloride	75-01-4	4.47	c	0.002	m	0.0205	5.53	c	9.21	c	0.002	m	0.0205	4600
Xylene (mixed isomers)	1330-20-7	936	ns	10	m	809	104	n	1410	ns	10	m	809	421
Zinc	7440-66-6	23500	n	4.67	n				613000	n	30.5	n		

Notes

n = The value is based on non-carcinogenic health risk, with a hazard index (HI) = 1.

c = The value is based on carcinogenic health risk with a target cancer risk of 10E-5.

ns or cs = The value is based upon health risk; however, the calculated saturation value is lower than the health risk value presented.

k = KDHE has established this value by means other than the equations in this manual.

m = The groundwater value is equal to the EPA MCL.

M = The groundwater value is equal to the EPA Secondary MCL.

Tier 2 Indoor Air values are presented in ug/m^3, which may be converted to parts per billion volume (ppbv) using the equation:

Tier 2 value (ug/m^3) x 24 / contaminant molecular weight (MW from App B) = concentration (ppbv)

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW	H' (unitless)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Kp (cm/hr)
Acenaphthene	83-32-9	154.21 a	7.50E-03 a	5.10E-02 a	8.30E-06 a	5027 a	3.9 a	8.60E-02 c
Acetochlor	34256-82-1	269.77 a	9.10E-07 a			298.4 a	223 a	4.95E-03 c
Acetone	67-64-1	58.08 a	1.40E-03 a	1.10E-01 a	1.10E-05 a	2.364 a	1000000 a	5.12E-04 c
Acetophenone	98-86-2	120.15 a	4.30E-04 a	6.50E-02 a	8.70E-06 a	51.85 a	6130 a	3.72E-03 c
Acrolein	107-02-8	56.06 a	5.00E-03 a	1.10E-01 a	1.20E-05 a	1 a	212000 a	6.50E-04 b
Acrylamide	79-06-1	71.08 a	7.00E-08 a			5.694 a	390000 a	2.20E-04 b
Acrylonitrile	107-13-1	53.06 a	5.60E-03 a	1.10E-01 a	1.20E-05 a	8.511 a	74500 a	1.20E-03 b
Alachlor (Lasso)	15972-60-8	269.77 a	3.40E-07 a			312.3 a	240 a	1.05E-02 c
Aldicarb (Temik)	116-06-3	190.26 a	5.90E-08 a			24.64 a	6030 a	7.55E-04 c
Aldrin	309-00-2	364.92 a	1.80E-03 a			82020 a	0.017 a	1.40E-03 b
Anthracene	120-12-7	178.24 a	2.30E-03 a	3.90E-02 a	7.90E-06 a	16360 a	0.0434 a	1.42E-01 c
Antimony	7440-36-0	124.78 a						1.00E-03 b
Arsenic	7440-38-2	77.95 a						1.00E-03 b
Atrazine	1912-24-9	215.69 a	9.60E-08 a			224.5 a	34.7 a	5.24E-03 c
Barium	7440-39-3	137.33 a						1.00E-03 b
Bentazon	25057-89-0	240.28 a	8.90E-08 a			10 a	500 a	2.52E-03 c
Benzene	71-43-2	78.11 a	2.30E-01 a	9.00E-02 a	1.00E-05 a	145.8 a	1790 a	1.50E-02 b
Benzidine	92-87-5	184.24 a	2.90E-09 a			1190 a	322 a	1.10E-03 b
Benzo(a)anthracene	56-55-3	228.3 a	4.90E-04 a			176900 a	0.0094 a	4.70E-01 b
Benzo(b)fluoranthene	205-99-2	252.32 a	2.70E-05 a			599400 a	0.0015 a	7.00E-01 b
Benzo(k)fluoranthene	207-08-9	252.32 a	2.40E-05 a			587400 a	0.0008 a	6.91E-01 c
Benzo(a)pyrene	50-32-8	252.32 a	1.90E-05 a			587400 a	0.00162 a	7.00E-01 b
Benzyl Chloride	100-44-7	126.59 a	1.70E-02 a	6.30E-02 a	8.80E-06 a	446.1 a	525 a	1.00E-02 b
Beryllium	7440-41-7	9.01 a						1.00E-03 b
Bis(2-chloroethyl)ether	111-44-4	143.01 a	7.00E-04 a	5.70E-02 a	8.70E-06 a	32.21 a	17200 a	1.80E-03 b
Bis(chloromethyl)ether	542-88-1	114.96 a	1.80E-01 a	7.60E-02 a	1.00E-05 a	9.699 a	22000 a	8.55E-04 c
Bis(2-ethylhexyl)phthalate	117-81-7	390.57 a	1.10E-05 a			119600 a	0.27 a	1.13E+00 c
Bromacil	314-40-9	261.12 c	5.69E-09 c			66.62 c	103.55 c	1.35E-03 c
Bromodichloromethane	75-27-4	163.83 a	8.70E-02 a	5.60E-02 a	1.10E-05 a	31.82 a	3030 a	4.60E-03 b
Bromoform	75-25-2	252.73 a	2.20E-02 a			31.82 a	3100 a	2.20E-03 b
Bromomethane	74-83-9	94.94 a	3.00E-01 a	1.00E-01 a	1.30E-05 a	13.22 a	15200 a	2.80E-03 b
1,3-Butadiene	106-99-0	54.09 a	3.00E+00 a	1.00E-01 a	1.00E-05 a	39.6 a	735 a	1.60E-02 b
Butyl Benzyl Phthalate	85-68-7	312.37 a	5.20E-05 a			7155 a	2.69 a	3.85E-02 c
Butylate	2008-41-5	217.37 a	3.50E-03 a			385.7 a	45 a	5.41E-02 c
n-Butylbenzene	104-51-8	134.22 c	5.69E-01 c	5.28E-02 d	7.33E-06 d	1482 c	16.8 c	2.25E-01 c

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW	H' (unitless)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Kp (cm/hr)
sec-Butylbenzene	135-98-8	134.22 c	5.69E-01 c	5.28E-02 d	7.33E-06 d	1331 c	28.2 c	3.01E-01 c
Cadmium	7440-43-9	112.41 a						1.00E-03 b
Caprolactam	105-60-2	113.16 a	1.00E-06 a			24.5 a	772000 a	1.00E-03 c
Captan	133-06-2	300.59 a	2.90E-07 a			252.2 a	5.1 a	1.20E-03 b
Carbaryl (Sevin)	63-25-2	201.23 a	1.30E-07 a			354.8 a	110 a	4.31E-03 c
Carbazole	86-74-8	167.21 c	3.54E-06 c			9161 c	14.2 c	5.36E-02 c
Carbofuran (Furadan)	1563-66-2	221.26 a	1.30E-07 a			95.25 a	320 a	3.13E-03 c
Carbon Disulfide	75-15-0	76.13 a	5.90E-01 a	1.10E-01 a	1.30E-05 a	21.73 a	2160 a	1.70E-02 b
Carbon Tetrachloride	56-23-5	153.82 a	1.10E+00 a	5.70E-02 a	9.80E-06 a	43.89 a	793 a	1.60E-02 b
Chlordane	12789-03-6	409.78 a	2.00E-03 a			33780 a	0.056 a	1.07E-01 c
Chlordecone (Kepone)	143-50-0	490.64 a	2.20E-06 a			17500 a	2.7 a	1.09E-02 c
Chlorobenzene	108-90-7	112.56 a	1.30E-01 a	7.20E-02 a	9.50E-06 a	233.9 a	498 a	2.80E-02 b
Chlorodifluoromethane	75-45-6	86.47 a	1.70E+00 a	1.00E-01 a	1.30E-05 a	31.82 a	2770 a	2.68E-03 c
Chloroform	67-66-3	119.38 a	1.50E-01 a	7.70E-02 a	1.10E-05 a	31.82 a	7950 a	6.80E-03 b
Chloromethane	74-87-3	50.49 a	3.60E-01 a	1.20E-01 a	1.40E-05 a	13.22 a	5320 a	3.30E-03 b
beta-Chloronaphthalene	91-58-7	162.62 a	1.30E-02 a	4.50E-02 a	7.70E-06 a	2478 a	11.7 a	7.49E-02 c
o-Chlorotoluene	95-49-8	126.59 a	1.50E-01 a	6.30E-02 a	8.70E-06 a	382.9 a	374 a	5.72E-02 c
Chlorpyrifos (Lorsban/Dursban)	2921-88-2	350.59 a	1.20E-04 a			7283 a	1.12 a	3.34E-02 c
Chromium (total)	18540-29-9	52.00 a					1690000 a	2.00E-03 b
Chrysene	218-01-9	228.3 a	2.10E-04 a			180500 a	0.002 a	4.70E-01 b
Cobalt	7440-48-4	58.93 a						4.00E-04 b
Copper	7440-50-8	63.55 a						1.00E-03 b
Cumene	98-82-8	120.2 a	4.70E-01 a	6.00E-02 a	7.90E-06 a	697.8 a	61.3 a	8.97E-02 c
Cyanazine (Bladex)	21725-46-2	240.7 a	1.10E-10 a			134.1 a	170 a	2.09E-03 c
Cyanide	57-12-5	27.03 a	5.40E-03 a					1.00E-03 b
Dacthal	1861-32-1	331.97 a	8.90E-05 a			511.1 a	0.5 a	1.50E-02 c
DDD	72-54-8	320.05 a	2.70E-04 a			117500 a	0.09 a	1.80E-01 b
DDE	72-55-9	318.03 a	1.70E-03 a			117500 a	0.04 a	1.60E-01 b
DDT	50-29-3	354.49 a	3.40E-04 a			168600 a	0.0055 a	2.70E-01 b
Diazinon	333-41-5	304.35 a	4.60E-06 a			3034 a	40 a	1.04E-02 c
Dibenzo(a,h)anthracene	53-70-3	278.36 a	5.80E-06 a			1912000 a	0.00249 a	1.50E+00 b
Dibenzofuran	132-64-9	168.2 a	8.70E-03 a	4.10E-02 a	7.40E-06 a	9161 a	3.1 a	9.75E-02 c
1,4-Dibromobenzene	106-37-6	235.91 a	3.70E-02 a			375.3 a	20 a	2.45E-02 c
Dibromochloromethane	124-48-1	208.28 a	3.20E-02 a			31.82 a	2700 a	2.89E-03 c
1,2-Dibromo-3-chloropropane	96-12-8	236.33 a	6.00E-03 a			115.8 a	1230 a	6.85E-03 c

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW	H' (unitless)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Kp (cm/hr)
Dibutyl Phthalate	84-74-2	278.35 a	7.40E-05 a			1157 a	11.2 a	2.40E-02 b
Dicamba	1918-00-9	221.04 a	8.90E-08 a			29.01 a	8310 a	2.65E-03 c
1,2-Dichlorobenzene	95-50-1	147 a	7.80E-02 a	5.60E-02 a	8.90E-06 a	382.9 a	156 a	4.10E-02 b
1,4-Dichlorobenzene	106-46-7	147 a	9.90E-02 a	5.50E-02 a	8.70E-06 a	375.3 a	81.3 a	4.20E-02 b
Dichlorodifluoromethane	75-71-8	120.91 a	1.40E+01 a	7.80E-02 a	9.10E-06 a	43.89 a	280 a	9.00E-03 b
1,1-Dichloroethane	75-34-3	98.96 a	2.30E-01 a	8.40E-02 a	1.10E-05 a	31.82 a	5040 a	6.70E-03 b
1,2-Dichloroethane	107-06-2	98.96 a	4.80E-02 a	8.60E-02 a	1.10E-05 a	39.6 a	8600 a	4.20E-03 b
1,1-Dichloroethylene	75-35-4	96.94 a	1.10E+00 a	8.60E-02 a	1.10E-05 a	31.82 a	2420 a	1.20E-02 b
cis-1,2-Dichloroethylene	156-59-2	96.94 a	1.70E-01 a	8.80E-02 a	1.10E-05 a	39.6 a	6410 a	1.10E-02 c
trans-1,2-Dichloroethylene	156-60-5	96.94 a	1.70E-01 a	8.80E-02 a	1.10E-05 a	39.6 a	4520 a	1.10E-02 c
2,4-Dichlorophenol	120-83-2	163 a	1.80E-04 a			491.8 a	4500 a	2.10E-02 b
4-(2,4-Dichlorophenoxy)butyric acid	94-82-6	249.10 a	2.40E-07 a			98.4 a	46 a	1.39E-02 c
2,4-Dichlorophenoxyacetic acid	94-75-7	221.04 a	1.40E-06 a			29.63 a	677 a	6.64E-03 c
1,2-Dichloropropane	78-87-5	112.99 a	1.20E-01 a	8.10E-02 a	9.50E-06 a	60.7 a	2800 a	7.80E-03 b
1,3-Dichloropropene	542-75-6	110.97 a	1.50E-01 a	8.20E-02 a	9.60E-06 a	72.17 a	2800 a	4.30E-03 b
Dichlorvos	62-73-7	220.98 a	2.30E-05 a			53.96 a	8000 a	8.50E-04 b
Dieldrin	60-57-1	380.91 a	4.10E-04 a			20090 a	0.195 a	1.20E-02 b
Diethyl Phthalate	84-66-2	222.24 a	2.50E-05 a			104.9 a	1080 a	3.90E-03 b
2,4-Dimethylphenol	105-67-9	122.17 a	3.90E-05 a			491.8 a	7870 a	1.10E-02 b
Dimethylphthalate	131-11-3	194 b	9.14E-06 c			31.59 c	7459 c	1.40E-03 b
2,4-Dinitrophenol	51-28-5	184.11 a	3.50E-06 a			460.8 a	2790 a	1.50E-03 b
2,4-Dinitrotoluene	121-14-2	182.14 a	2.20E-06 a			575.6 a	200 a	3.10E-03 b
2,6-Dinitrotoluene	606-20-2	182.14 a	3.10E-05 a			587.4 a	150.62 a	2.10E-03 b
Di-n-octyl Phthalate	117-84-0	390.57 c	4.83E-04 c			141000 c	0.00046 c	2.43E+00 c
1,4-Dioxane	123-91-1	88.11 a	2.00E-04 a			2.633 a	1000000 a	3.30E-04 b
Dioxin (2,3,7,8-TCDD)	1746-01-6	321.98 a	2.00E-03 a			249100 a	0.0002 a	8.10E-01 b
Diphenylamine	122-39-4	169.23 a	1.10E-04 a			825.8 a	53 a	3.73E-02 c
Diuron	330-54-1	233.1 a	2.10E-08 a			109.1 a	42 a	4.66E-03 c
Endosulfan	115-29-7	406.92 a	2.70E-03 a			6761 a	0.325 a	2.86E-03 c
Endrin	72-20-8	380.91 a	4.10E-04 a			20090 a	0.25 a	1.20E-02 b
Ethyl Chloride	75-00-3	64.52 a	4.50E-01 a	1.00E-01 a	1.20E-05 a	21.73 a	6710 a	6.10E-03 b
s-Ethyl Dipropylthiocarbamate (EPTC)	759-94-4	189.32 a	6.50E-04 a	2.90E-02 a	6.40E-06 a	164.1 a	375 a	1.84E-02 c
Ethylbenzene	100-41-4	106.17 a	3.20E-01 a	6.80E-02 a	8.50E-06 a	446.1 a	169 a	4.90E-02 b
Ethylene Dibromide	106-93-4	187.86 a	2.70E-02 a	4.30E-02 a	1.00E-05 a	39.6 a	3910 a	2.80E-03 b
Ethylene Glycol	107-21-1	62.07 a	2.50E-06 a			1 a	1000000 a	8.77E-05 c

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW	H' (unitless)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Kp (cm/hr)
Fluoranthene	206-44-0	202.26 a	3.60E-04 a			55450 a	0.26 a	2.20E-01 b
Fluorene	86-73-7	166.22 a	3.90E-03 a	4.40E-02 a	7.90E-06 a	9160 a	1.69 a	1.10E-01 c
Fonofos (Dyfonate)	944-22-9	246.32 a	2.90E-04 a			855.8 a	15.7 a	2.70E-02 c
Formaldehyde	50-00-0	30.03 a	1.40E-05 a			1 a	400000 a	1.80E-03 b
Furan	110-00-9	68.08 a	2.20E-01 a	1.00E-01 a	1.20E-05 a	79.99 a	10000 a	5.05E-03 c
Glyphosate (Roundup)	1071-83-6	169.07 a	8.60E-11 a			1 a	10500 a	9.69E-07 c
Heptachlor	76-44-8	373.32 a	1.20E-02 a			41260 a	0.18 a	1.43E-01 c
Heptachlor Epoxide	1024-57-3	389.32 a	8.60E-04 a			10110 a	0.2 a	2.09E-02 c
Hexachlorobenzene	118-74-1	284.78 a	7.00E-02 a			6195 a	0.0062 a	1.30E-01 b
Hexachlorobutadiene	87-68-3	260.76 a	4.20E-01 a			845.2 a	3.2 a	8.10E-02 b
gamma-Hexachlorocyclohexane (Lindane)	58-89-9	290.83 a	2.10E-04 a			2807 a	7.3 a	1.10E-02 b
Hexachlorocyclopentadiene	77-47-4	272.77 a	1.10E+00 a			1404 a	1.8 a	1.03E-01 c
Hexachloroethane	67-72-1	236.74 a	1.60E-01 a			196.8 a	50 a	3.00E-02 b
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	222.12 a	8.20E-10 a			89.07 a	59.7 a	3.36E-04 c
n-Hexane	110-54-3	86.18 a	7.40E+01 a	7.30E-02 a	8.20E-06 a	131.5 a	9.5 a	2.01E-01 c
Hydrazine	302-01-2	32.05 a					1000000 a	4.40E-05 b
Hydrazine Sulfate	10034-93-2	128.1 a					30550 a	4.40E-05 b
Indeno(1,2,3-cd)pyrene	193-39-5	276.34 a	1.40E-05 a			1951000 a	0.00019 a	1.00E+00 b
Lead	7439-92-1	207.2 a						3.29E-04 c
Malathion	121-75-5	330.35 a	2.00E-07 a			31.27 a	143 a	8.12E-04 c
Manganese	7439-96-5	54.94 a						1.00E-03 b
Mercury	7439-97-6	200.59 a	4.70E-01 a				0.06 a	1.00E-03 b
Methoxychlor	72-43-5	345.66 a	8.30E-06 a			26890 a	0.1 a	4.28E-02 c
Methyl Ethyl Ketone	78-93-3	72.11 a	2.30E-03 a	9.10E-02 a	1.00E-05 a	4.51 a	223000 a	9.60E-04 b
Methyl Isobutyl Ketone	108-10-1	100.16 a	5.60E-03 a	7.00E-02 a	8.30E-06 a	12.6 a	19000 a	3.19E-03 c
Methyl tert-Butyl Ether	1634-04-4	88.15 a	2.40E-02 a	7.50E-02 a	8.60E-06 a	11.56 a	51000 a	2.11E-03 c
Methylene Chloride	75-09-2	84.93 a	1.30E-01 a	1.00E-01 a	1.30E-05 a	21.73 a	13000 a	3.50E-03 b
2-Methylnaphthalene	91-57-6	142.2 a	2.10E-02 a	5.20E-02 a	7.80E-06 a	2478 a	24.6 a	9.17E-02 c
2-Methylphenol	95-48-7	108.14 a	4.90E-05 a			306.5 a	25900 a	7.70E-03 b
3-Methylphenol	108-39-4	108.14 a	3.50E-05 a			300.4 a	22700 a	7.80E-03 b
4-Methylphenol	106-44-5	108.14 a	4.10E-05 a			300.4 a	21500 a	7.70E-03 b
Metolachlor (Dual)	51218-45-2	283.8 a	3.70E-07 a			488.5 a	530 a	3.39E-03 c
Metribuzin (Sencor)	21087-64-9	214.29 a	4.80E-09 a			53.13 a	1050 a	1.32E-03 c
Naphthalene	91-20-3	128.18 a	1.80E-02 a	6.00E-02 a	8.40E-06 a	1544 a	31 a	4.70E-02 b
Nickel	7440-02-0	58.69 a						2.00E-04 b

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW	H' (unitless)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Kp (cm/hr)
Nitrobenzene	98-95-3	123.11 a	9.80E-04 a	6.80E-02 a	9.40E-06 a	226.4 a	2090 a	5.41E-03 c
Nitrofurazone	59-87-0	198.14 a	1.30E-11 a			349.7 a	210 a	1.72E-04 c
Nitroguanidine	556-88-7	104.07 a	1.80E-10 a			20.65 a	4400 a	1.05E-04 c
2-Nitropropane	79-46-9	89.09 a	4.90E-03 a	8.50E-02 a	1.00E-05 a	30.8 a	17000 a	8.80E-04 b
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0	296.16 a	3.50E-08 a			531.6 a	5 a	4.36E-05 c
Oxamyl	23135-22-0	219.26 a	9.70E-09 a			10 a	280000 a	4.49E-05 c
Paraquat	1910-42-5	257.16 a	1.30E-11 a			6780 a	700000 a	8.92E-07 c
Parathion	56-38-2	291.26 a	1.20E-05 a			2422 a	11 a	1.30E-02 b
Pendimethalin (Prowl)	40487-42-1	281.31 a	3.50E-05 a			5615 a	0.3 a	1.15E-01 c
Pentachlorophenol	87-86-5	266.34 a	1.00E-06 a			4959 a	14 a	3.90E-01 b
Perchlorate	7790-98-9	117.49 a					245000 a	1.00E-03 b
Permethrin (Ambush)	52645-53-1	391.3 a	7.60E-05 a			118800 a	0.006 a	2.08E-01 c
Phenol	108-95-2	94.11 a	1.40E-05 a			187.2 a	82800 a	4.30E-03 b
Phenylphenol	90-43-7	170.21 a	4.30E-05 a			6722 a	700 a	1.96E-02 c
Phosphine	7803-51-2	34 a					3.3 a	1.00E-03 b
Picloram (Tordon)	1918-02-1	241.46 a	2.20E-12 a			38.77 a	430 a	1.27E-03 c
Profluralin	26399-36-0	347.3 a	1.20E-02 a			30520 a	0.1 a	9.00E-02 c
Prometon	1610-18-0	225.3 a	3.70E-08 a			137.4 a	750 a	8.27E-03 c
Propachlor (Ramrod)	1918-16-7	211.69 a	1.50E-05 a			204.5 a	580 a	2.86E-03 c
Propazine (Miloguard)	139-40-2	229.71 a	1.90E-07 a			344.1 a	8.6 a	7.13E-03 c
n-Propylbenzene	103-65-1	120.2 a	4.30E-01 a	6.00E-02 a	7.80E-06 a	813.1 a	52.2 a	9.39E-02 c
Pyrene	129-00-0	202.26 a	4.90E-04 a			54340 a	0.135 a	2.01E-01 c
Pyridine	110-86-1	79.1 a	4.50E-04 a	9.30E-02 a	1.10E-05 a	71.72 a	1000000 a	1.52E-03 c
Selenium	7782-49-2	80.98 a						1.00E-03 b
Silver	7440-22-4	107.87 a						6.00E-04 b
Simazine (Princap)	122-34-9	201.66 a	3.90E-08 a			146.5 a	6.2 a	3.25E-03 c
Styrene	100-42-5	104.15 a	1.10E-01 a	7.10E-02 a	8.80E-06 a	446.1 a	310 a	3.70E-02 b
Terbacil (Sinbar)	5902-51-2	216.67 a	4.90E-09 a			50.1 a	710 a	1.72E-03 c
Terbufos (Counter)	13071-79-9	288.42 a	9.80E-04 a			998.9 a	5.07 a	3.58E-02 c
Tert-butyl Alcohol	75-65-0	74.12 c	4.08E-04 c			2.11 c	151000 c	1.03E-03 c
1,1,1,2-Tetrachloroethane	630-20-6	167.85 a	1.00E-01 a	4.80E-02 a	9.10E-06 a	86.03 a	1070 a	1.59E-02 c
1,1,2,2-Tetrachloroethane	79-34-5	167.85 a	1.50E-02 a	4.90E-02 a	9.30E-06 a	94.94 a	2830 a	6.90E-03 b
Tetrachloroethylene	127-18-4	165.83 a	7.20E-01 a	5.00E-02 a	9.50E-06 a	94.94 a	206 a	3.30E-02 b
2,3,4,6-Tetrachlorophenol	58-90-2	231.89 a	3.60E-04 a			2969 a	23 a	7.10E-02 c
Tetryl	479-45-8	287.15 a	1.10E-07 a			4605 a	74 a	4.74E-04 c

APPENDIX B - CONTAMINANT SPECIFIC PARAMETERS

Contaminant	CAS No.	MW		H' (unitless)		Dia (cm^2/s)		Diw (cm^2/s)		Koc (L/kg)		S (mg/L)		Kp (cm/hr)	
Toluene	108-88-3	92.14	a	2.70E-01	a	7.80E-02	a	9.20E-06	a	233.9	a	526	a	3.10E-02	b
Total Petroleum Hydrocarbons (GRO)															
Total Petroleum Hydrocarbons (DRO)															
Toxaphene	8001-35-2	413.82	a	2.50E-04	a					77200	a	0.0069682	a	1.20E-02	b
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.38	a	2.20E+01	a	3.80E-02	a	8.60E-06	a	196.8	a	170	a	1.75E-02	c
1,2,4-Trichlorobenzene	120-82-1	181.45	a	5.80E-02	a	4.00E-02	a	8.40E-06	a	1356	a	49	a	6.60E-02	b
1,1,1-Trichloroethane	71-55-6	133.41	a	7.00E-01	a	6.50E-02	a	9.60E-06	a	43.89	a	1290	a	1.30E-02	b
1,1,2-Trichloroethane	79-00-5	133.41	a	3.40E-02	a	6.70E-02	a	1.00E-05	a	60.7	a	4590	a	6.40E-03	b
Trichloroethylene	79-01-6	131.39	a	4.00E-01	a	6.90E-02	a	1.00E-05	a	60.7	a	1280	a	1.20E-02	b
Trichlorofluoromethane	75-69-4	137.37	a	4.00E+00	a	6.50E-02	a	1.00E-05	a	43.89	a	1100	a	1.30E-02	b
2,4,5-Trichlorophenol	95-95-4	197.45	a	6.60E-05	a					1777	a	1200	a	3.62E-02	c
2,4,6-Trichlorophenol	88-06-2	197.45	a	1.10E-04	a					1777	a	800	a	3.50E-02	b
2,4,5-Trichlorophenoxyacetic Acid	93-76-5	255.49	a	1.90E-06	a					107	a	278	a	9.14E-03	c
2,4,5-Trichlorophenoxypropionic acid	93-72-1	269.51	a	3.70E-07	a					175.3	a	71	a	1.61E-02	c
1,2,3-Trichloropropane	96-18-4	147.43	a	1.40E-02	a	5.70E-02	a	9.20E-06	a	115.8	a	1750	a	7.52E-03	c
Trifluralin (Treflan)	1582-09-8	335.29	a	4.20E-03	a					16390	a	0.184	a	7.28E-02	c
1,2,4-Trimethylbenzene	95-63-6	120.2	a	2.50E-01	a	6.10E-02	a	7.90E-06	a	614.3	a	57	a	8.57E-02	c
1,3,5-Trimethylbenzene	108-67-8	120.2	a	3.60E-01	a	6.00E-02	a	7.80E-06	a	602.1	a	48.2	a	6.21E-02	c
2,4,6-Trinitrotoluene	118-96-7	227.13	a	8.50E-07	a					2812	a	115	a	9.63E-04	c
Vinyl Acetate	108-05-4	86.09	a	2.10E-02	a	8.50E-02	a	1.00E-05	a	5.583	a	20000	a	1.57E-03	c
Vinyl Chloride	75-01-4	62.5	a	1.10E+00	a	1.10E-01	a	1.20E-05	a	21.73	a	8800	a	5.60E-03	b
Xylene (mixed isomers)	1330-20-7	106.17	a	2.10E-01	a	8.50E-02	a	9.90E-06	a	382.9	a	106	a	4.71E-02	c
Zinc	7440-66-6	67.41	a											6.00E-04	b

Notes

MW = Molecular Weight; H' = Unitless Henry's Law Constant; Dia = Diffusivity in Air; Diw = Diffusivity in Water; Koc = Soil organic carbon/water partition coefficient; S = Solubility; Kp = Skin permeability coefficient

Sources of information

a = USEPA Regional Screening Level Chemical-specific Parameters Supporting Table, May 17, 2010

b = USEPA "Risk Assessment Guidance for Superfund Volume I, Part E, July 2004

c = USEPA EPI Suite v4.0

d = The Risk Assessment Information System (RAIS) website, June 22, 2010

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)		RfC (mg/m^3)		SfO $(mg/kg\text{-}day)^{-1}$		IUR $(ug/m^3)^{-1}$	
Acenaphthene	83-32-9	6.00E-02	i	2.10E-01	r				
Acetochlor	34256-82-1	2.00E-02	i	7.00E-02	r				
Acetone	67-64-1	9.00E-01	i	3.10E+01	e				
Acetophenone	98-86-2	1.00E-01	i	3.50E-01	r				
Acrolein	107-02-8	5.00E-04	i	2.00E-05	i				
Acrylamide	79-06-1	2.00E-03	i	6.00E-03	i	5.00E-01	i	1.00E-04	i
Acrylonitrile	107-13-1	4.00E-02	e	2.00E-03	i	5.40E-01	i	6.80E-05	i
Alachlor (Lasso)	15972-60-8	1.00E-02	i	3.50E-02	r	5.60E-02	e	1.60E-05	r
Aldicarb (Temik)	116-06-3	1.00E-03	i	3.50E-03	r				
Aldrin	309-00-2	3.00E-05	i	1.05E-04	r	1.70E+01	i	4.90E-03	i
Anthracene	120-12-7	3.00E-01	i	1.05E+00	r				
Antimony	7440-36-0	4.00E-04	i	1.40E-03	r				
Arsenic	7440-38-2	3.00E-04	i	1.50E-05	e	1.50E+00	i	4.30E-03	
Atrazine	1912-24-9	3.50E-02	i	1.23E-01	r	2.30E-01	e	6.57E-05	r
Barium	7440-39-3	2.00E-01	i	5.00E-04	e				
Bentazon	25057-89-0	3.00E-02	i	1.05E-01	r				
Benzene	71-43-2	4.00E-03	i	3.00E-02	i	5.50E-02	i	7.80E-06	i
Benzidine	92-87-5	3.00E-03	i	1.05E-02	r	2.30E+02	i	6.70E-02	i
Benzo(a)anthracene	56-55-3					7.30E-01	e	1.10E-04	e
Benzo(b)fluoranthene	205-99-2					7.30E-01	e	1.10E-04	e
Benzo(k)fluoranthene	207-08-9					7.30E-02	e	1.10E-04	e
Benzo(a)pyrene	50-32-8					7.30E+00	i	1.10E-03	e
Benzyl Chloride	100-44-7	2.00E-03	e	1.00E-03	e	1.70E-01	i	4.90E-05	e
Beryllium	7440-41-7	2.00E-03	i	2.00E-05	i			2.40E-03	i
Bis(2-chloroethyl)ether	111-44-4					1.10E+00	i	3.30E-04	i
Bis(chloromethyl)ether	542-88-1					2.20E+02	i	6.20E-02	i
Bis(2-ethylhexyl)phthalate	117-81-7	2.00E-02	i	7.00E-02	r	1.40E-02	i	2.40E-06	e
Bromacil	314-40-9	1.00E-01	o	3.50E-01	r				
Bromodichloromethane	75-27-4	2.00E-02	i	7.00E-02	r	6.20E-02	i	3.70E-05	e
Bromoform	75-25-2	2.00E-02	i	7.00E-02	r	7.90E-03	i	1.10E-06	i

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)		RfC (mg/m^3)		SfO $(mg/kg\text{-}day)^{-1}$		IUR $(ug/m^3)^{-1}$	
Bromomethane	74-83-9	1.40E-03	i	5.00E-03	i				
1,3-Butadiene	106-99-0	5.71E-04	r	2.00E-03	i	3.40E+00	e	3.00E-05	i
Butyl Benzyl Phthalate	85-68-7	2.00E-01	i	7.00E-01	r	1.90E-03	e	5.43E-07	r
Butylate	2008-41-5	5.00E-02	i	1.75E-01	r				
n-Butylbenzene	104-51-8	1.00E-02	o	3.50E-02	r				
sec-Butylbenzene	135-98-8	1.00E-02	o	3.50E-02	r				
Cadmium	7440-43-9	5.00E-04	i	1.00E-05	e			1.80E-03	i
Caprolactam	105-60-2	5.00E-01	i	1.75E+00	r				
Captan	133-06-2	1.30E-01	i	4.55E-01	r	2.30E-03	e	6.60E-07	e
Carbaryl (Sevin)	63-25-2	1.00E-01	i	3.50E-01	r				
Carbazole	86-74-8					2.00E-02	h	5.71E-06	r
Carbofuran (Furadan)	1563-66-2	5.00E-03	i	1.75E-02	r				
Carbon Disulfide	75-15-0	1.00E-01	i	7.00E-01	i				
Carbon Tetrachloride	56-23-5	4.00E-03	i	1.00E-01	i	7.00E-02	i	6.00E-06	i
Chlordane	12789-03-6	5.00E-04	i	7.00E-04	i	3.50E-01	i	1.00E-04	i
Chlordecone (Kepone)	143-50-0	3.00E-04	i	1.05E-03	r	1.00E+01	i	4.60E-03	e
Chlorobenzene	108-90-7	2.00E-02	i	5.00E-02	e				
Chlorodifluoromethane	75-45-6	1.43E+01	r	5.00E+01	i				
Chloroform	67-66-3	1.00E-02	i	9.80E-02	e	3.10E-02	e	2.30E-05	i
Chloromethane	74-87-3	2.57E-02	r	9.00E-02	i				
beta-Chloronaphthalene	91-58-7	8.00E-02	i	2.80E-01	r				
o-Chlorotoluene	95-49-8	2.00E-02	i	7.00E-02	r				
Chlorpyrifos (Lorsban/Dursban)	2921-88-2	3.00E-03	i	1.05E-02	r				
Chromium (total)	18540-29-9	3.00E-03	i	1.00E-04	i	5.00E-01	e	1.20E-02	i
Chrysene	218-01-9					7.30E-03	e	1.10E-05	e
Cobalt	7440-48-4	3.00E-04	e	6.00E-06	e			9.00E-03	e
Copper	7440-50-8	4.00E-02	e	1.40E-01	r				
Cumene	98-82-8	1.00E-01	i	4.00E-01	i				
Cyanazine (Bladex)	21725-46-2	2.00E-03	e	7.00E-03	r	8.40E-01	e	2.40E-04	r
Cyanide	57-12-5	2.00E-02	i	7.00E-02	r				

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)		RfC (mg/m^3)		SfO $(mg/kg\text{-}day)^{-1}$		IUR $(ug/m^3)^{-1}$	
Dacthal	1861-32-1	1.00E-02	i	3.50E-02	r				
DDD	72-54-8					2.40E-01	i	6.90E-05	e
DDE	72-55-9					3.40E-01	i	9.70E-05	e
DDT	50-29-3	5.00E-04	i	1.75E-03	r	3.40E-01	i	9.70E-05	i
Diazinon	333-41-5	7.00E-04	e	2.45E-03	r				
Dibenzo(a,h)anthracene	53-70-3					7.30E+00	e	1.20E-03	e
Dibenzofuran	132-64-9	1.00E-03	e	3.50E-03	r				
1,4-Dibromobenzene	106-37-6	1.00E-02	i	3.50E-02	r				
Dibromochloromethane	124-48-1	2.00E-02	i	7.00E-02	r	8.40E-02	i	2.70E-05	e
1,2-Dibromo-3-chloropropane	96-12-8	2.00E-04	e	2.00E-04	i	8.00E-01	e	6.00E-03	e
Dibutyl Phthalate	84-74-2	1.00E-01	i	3.50E-01	r				
Dicamba	1918-00-9	3.00E-02	i	1.05E-01	r				
1,2-Dichlorobenzene	95-50-1	9.00E-02	i	2.00E-01	e				
1,4-Dichlorobenzene	106-46-7	7.00E-02	e	8.00E-01	i	5.40E-03	e	1.10E-05	e
Dichlorodifluoromethane	75-71-8	2.00E-01	i	2.00E-01	e				
1,1-Dichloroethane	75-34-3	2.00E-01	e	7.00E-01	r	5.70E-03	e	1.60E-06	e
1,2-Dichloroethane	107-06-2	2.00E-02	e	2.40E+00	e	9.10E-02	i	2.60E-05	i
1,1-Dichloroethylene	75-35-4	5.00E-02	i	2.00E-01	i				
cis-1,2-Dichloroethylene	156-59-2	1.00E-02	e	3.50E-02	r				
trans-1,2-Dichloroethylene	156-60-5	2.00E-02	i	6.00E-02	e				
2,4-Dichlorophenol	120-83-2	3.00E-03	i	1.05E-02	r				
4-(2,4-Dichlorophenoxy)butyric acid	94-82-6	8.00E-03	i	2.80E-02	r				
2,4-Dichlorophenoxyacetic acid	94-75-7	1.00E-02	i	3.50E-02	r				
1,2-Dichloropropane	78-87-5	9.00E-02	e	4.00E-03	i	3.60E-02	e	1.00E-05	e
1,3-Dichloropropene	542-75-6	3.00E-02	i	2.00E-02	i	1.00E-01	i	4.00E-06	i
Dichlorvos	62-73-7	5.00E-04	i	5.00E-04	i	2.90E-01	i	8.30E-05	e
Dieldrin	60-57-1	5.00E-05	i	1.75E-04	r	1.60E+01	i	4.60E-03	i
Diethyl Phthalate	84-66-2	8.00E-01	i	2.80E+00	r				
2,4-Dimethylphenol	105-67-9	2.00E-02	i	7.00E-02	r				
Dimethylphthalate	131-11-3	1.00E+01	o	3.50E+01	r				

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)		RfC (mg/m^3)		SfO $(mg/kg\text{-}day)^{-1}$		IUR $(ug/m^3)^{-1}$	
2,4-Dinitrophenol	51-28-5	2.00E-03	i	7.00E-03	r				
2,4-Dinitrotoluene	121-14-2	2.00E-03	i	7.00E-03	r	3.10E-01	e	8.90E-05	e
2,6-Dinitrotoluene	606-20-2	1.00E-03	e	3.50E-03	r				
Di-n-octyl Phthalate	117-84-0	2.00E-02	h	7.00E-02	r				
1,4-Dioxane	123-91-1	1.00E-01	e	3.60E+00	e	1.10E-02	i	7.70E-06	e
Dioxin (2,3,7,8-TCDD)	1746-01-6	1.00E-09	e	4.00E-08	e	1.30E+05	e	3.80E+01	e
Diphenylamine	122-39-4	2.50E-02	i	8.75E-02	r				
Diuron	330-54-1	2.00E-03	i	7.00E-03	r				
Endosulfan	115-29-7	6.00E-03	i	2.10E-02	r				
Endrin	72-20-8	3.00E-04	i	1.05E-03	r				
Ethyl Chloride	75-00-3	2.86E+00	r	1.00E+01	i				
s-Ethyl Dipropylthiocarbamate (EPTC)	759-94-4	2.50E-02	i	8.75E-02	r				
Ethylbenzene	100-41-4	1.00E-01	i	1.00E+00	i	1.10E-02	e	2.50E-06	e
Ethylene Dibromide	106-93-4	9.00E-03	i	9.00E-03	i	2.00E+00	i	6.00E-04	i
Ethylene Glycol	107-21-1	2.00E+00	i	4.00E-01	e				
Fluoranthene	206-44-0	4.00E-02	i	1.40E-01	r				
Fluorene	86-73-7	4.00E-02	i	1.40E-01	r				
Fonofos (Dyfonate)	944-22-9	2.00E-03	i	7.00E-03	r				
Formaldehyde	50-00-0	2.00E-01	i	9.80E-03	e	4.55E-02	r	1.30E-05	i
Furan	110-00-9	1.00E-03	i	3.50E-03	r				
Glyphosate (Roundup)	1071-83-6	1.00E-01	i	3.50E-01	r				
Heptachlor	76-44-8	5.00E-04	i	1.75E-03	r	4.50E+00	i	1.30E-03	i
Heptachlor Epoxide	1024-57-3	1.30E-05	i	4.55E-05	r	9.10E+00	i	2.60E-03	i
Hexachlorobenzene	118-74-1	8.00E-04	i	2.80E-03	r	1.60E+00	i	4.60E-04	i
Hexachlorobutadiene	87-68-3	1.00E-03	e	3.50E-03	r	7.80E-02	i	2.20E-05	i
gamma-Hexachlorocyclohexane (Lindane)	58-89-9	3.00E-04	i	1.05E-03	r	1.10E+00	e	3.10E-04	e
Hexachlorocyclopentadiene	77-47-4	6.00E-03	i	2.00E-04	i				
Hexachloroethane	67-72-1	1.00E-03	i	3.50E-03	r	1.40E-02	i	4.00E-06	i
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	3.00E-03	i	1.05E-02	r	1.10E-01	i	3.14E-05	r
n-Hexane	110-54-3	6.00E-02	e	7.00E-01	i				

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)	RfC (mg/m^3)	SfO $(mg/kg\text{-}day)^{-1}$	IUR $(ug/m^3)^{-1}$
Hydrazine	302-01-2		3.00E-05 e	3.00E+00 i	4.90E-03 i
Hydrazine Sulfate	10034-93-2			3.00E+00 i	4.90E-03 i
Indeno(1,2,3-cd)pyrene	193-39-5			7.30E-01 e	1.10E-04 e
Lead	7439-92-1				
Malathion	121-75-5	2.00E-02 i	7.00E-02 r		
Manganese	7439-96-5	1.40E-01 i	5.00E-05 i		
Mercury	7439-97-6	1.60E-04 e	3.00E-04 i		
Methoxychlor	72-43-5	5.00E-03 i	1.75E-02 r		
Methyl Ethyl Ketone	78-93-3	6.00E-01 i	5.00E+00 i		
Methyl Isobutyl Ketone	108-10-1	8.00E-02 e	3.00E+00 i		
Methyl tert-Butyl Ether	1634-04-4	8.57E-01 r	3.00E+00 i	1.80E-03 e	2.60E-07 e
Methylene Chloride	75-09-2	6.00E-02 i	1.00E+00 e	7.50E-03 i	4.70E-07 i
2-Methylnaphthalene	91-57-6	4.00E-03 i	1.40E-02 r		
2-Methylphenol	95-48-7	5.00E-02 i	6.00E-01 e		
3-Methylphenol	108-39-4	5.00E-02 i	6.00E-01 e		
4-Methylphenol	106-44-5	5.00E-03 e	6.00E-01 e		
Metolachlor (Dual)	51218-45-2	1.50E-01 i	5.25E-01 r		
Metribuzin (Sencor)	21087-64-9	2.50E-02 i	8.75E-02 r		
Naphthalene	91-20-3	2.00E-02 i	3.00E-03 i	1.19E-01 r	3.40E-05 e
Nickel	7440-02-0	2.00E-02 i	9.00E-05 e		2.60E-04 e
Nitrobenzene	98-95-3	2.00E-03 i	9.00E-03 i	1.40E-01 r	4.00E-05 i
Nitrofurazone	59-87-0			1.30E+00 e	3.70E-04 e
Nitroguanidine	556-88-7	1.00E-01 i	3.50E-01 r		
2-Nitropropane	79-46-9	5.71E-03 r	2.00E-02 i	9.45E+00 r	2.70E-03 e
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0	5.00E-02 i	1.75E-01 r		
Oxamyl	23135-22-0	2.50E-02 i	8.75E-02 r		
Paraquat	1910-42-5	4.50E-03 i	1.58E-02 r		
Parathion	56-38-2	6.00E-03 e	2.10E-02 r		
Pendimethalin (Prowl)	40487-42-1	4.00E-02 i	1.40E-01 r		
Pentachlorophenol	87-86-5	3.00E-02 i	1.05E-01 r	1.20E-01 i	5.10E-06 e

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)	RfC (mg/m^3)	SfO $(mg/kg\text{-}day)^{-1}$	IUR $(ug/m^3)^{-1}$
Perchlorate	7790-98-9	7.00E-04 i	2.45E-03 r		
Permethrin (Ambush)	52645-53-1	5.00E-02 i	1.75E-01 r		
Phenol	108-95-2	3.00E-01 i	2.00E-01 e		
Phenylphenol	90-43-7			1.90E-03 e	5.43E-07 r
Phosphine	7803-51-2	3.00E-04 i	3.00E-04 i		
Picloram (Tordon)	1918-02-1	7.00E-02 i	2.45E-01 r		
Profluralin	26399-36-0	6.00E-03 e	2.10E-02 r		
Prometon	1610-18-0	1.50E-02 i	5.25E-02 r		
Propachlor (Ramrod)	1918-16-7	1.30E-02 i	4.55E-02 r		
Propazine (Miloguard)	139-40-2	2.00E-02 i	7.00E-02 r		
n-Propylbenzene	103-65-1	1.00E-01 e	1.00E+00 e		
Pyrene	129-00-0	3.00E-02 i	1.05E-01 r		
Pyridine	110-86-1	1.00E-03 i	3.50E-03 r		
Selenium	7782-49-2	5.00E-03 i	2.00E-02 e		
Silver	7440-22-4	5.00E-03 i	1.75E-02 r		
Simazine (Princap)	122-34-9	5.00E-03 i	1.75E-02 r	1.20E-01 e	3.43E-05 r
Styrene	100-42-5	2.00E-01 i	1.00E+00 i		
Terbacil (Sinbar)	5902-51-2	1.30E-02 i	4.55E-02 r		
Terbufos (Counter)	13071-79-9	2.50E-05 e	8.75E-05 r		
Tert-butyl Alcohol	75-65-0			3.30E-03 c	9.43E-07 r
1,1,1,2-Tetrachloroethane	630-20-6	3.00E-02 i	1.05E-01 r	2.60E-02 i	7.40E-06 i
1,1,2,2-Tetrachloroethane	79-34-5	4.00E-03 e	1.40E-02 r	2.00E-01 i	5.80E-05 i
Tetrachloroethylene	127-18-4	1.00E-02 i	2.70E-01 e	5.40E-01 e	5.90E-06 e
2,3,4,6-Tetrachlorophenol	58-90-2	3.00E-02 i	1.05E-01 r		
Tetryl	479-45-8	4.00E-03 e	1.40E-02 r		
Toluene	108-88-3	8.00E-02 i	5.00E+00 i		
Total Petroleum Hydrocarbons (GRO)					
Total Petroleum Hydrocarbons (DRO)					
Toxaphene	8001-35-2			1.10E+00 i	3.20E-04 i
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	3.00E-01 i	3.00E+01 e		

APPENDIX C - CONTAMINANT TOXICITY DATA

Contaminant	CAS No.	RfDo (mg/kg-day)		RfC (mg/m^3)		SfO $(mg/kg\text{-}day)^{-1}$		IUR $(ug/m^3)^{-1}$	
1,2,4-Trichlorobenzene	120-82-1	1.00E-02	i	2.00E-03	e	2.90E-02	e	8.29E-06	r
1,1,1-Trichloroethane	71-55-6	2.00E+00	i	5.00E+00	i				
1,1,2-Trichloroethane	79-00-5	4.00E-03	i	1.40E-02	r	5.70E-02	i	1.60E-05	i
Trichloroethylene	79-01-6					5.90E-03	e	2.00E-06	e
Trichlorofluoromethane	75-69-4	3.00E-01	i	7.00E-01	e				
2,4,5-Trichlorophenol	95-95-4	1.00E-01	i	3.50E-01	r				
2,4,6-Trichlorophenol	88-06-2	1.00E-03	e	3.50E-03	r	1.10E-02	i	3.10E-06	i
2,4,5-Trichlorophenoxyacetic Acid	93-76-5	1.00E-02	i	3.50E-02	r				
2,4,5-Trichlorophenoxypropionic acid	93-72-1	8.00E-03	i	2.80E-02	r				
1,2,3-Trichloropropane	96-18-4	4.00E-03	i	3.00E-04	i	3.00E+01	i	8.57E-03	r
Trifluralin (Treflan)	1582-09-8	7.50E-03	i	2.63E-02	r	7.70E-03	i	2.20E-06	r
1,2,4-Trimethylbenzene	95-63-6	2.00E-03	r	7.00E-03	e				
1,3,5-Trimethylbenzene	108-67-8	1.00E-02	e	3.50E-02	r				
2,4,6-Trinitrotoluene	118-96-7	5.00E-04	i	1.75E-03	r	3.00E-02	i	8.57E-06	r
Vinyl Acetate	108-05-4	1.00E+00	e	2.00E-01	i				
Vinyl Chloride	75-01-4	3.00E-03	i	1.00E-01	i	7.20E-01	i	4.40E-06	i
Xylene (mixed isomers)	1330-20-7	2.00E-01	i	1.00E-01	i				
Zinc	7440-66-6	3.00E-01	i	1.05E+00	r				

Sources of Information

i = USEPA Integrated Risk Information System (IRIS) website, June 2010
e = USEPA Regional Screening Level (RSL) Tables, May 17, 2010
h = USEPA Health Effects Assessment Summary Tables, July 1997
o = Other EPA documents used by KDHE
c = California Office of Environmental Health Hazard Assessment
r = route-to-route extrapolation

USEPA National Recommended Water Quality Criteria
(January 2013)

Water Home
Drinking Water
Education & Training
Grants & Funding
Laws & Regulations
Our Waters
Pollution Prevention & Control
Resources & Performance
Science & Technology
Analytical Methods & Laboratories
Applications & Databases
Climate Change & Water
Contaminants of Emerging Concern
Drinking Water
Monitoring & Assessment
Research & Risk Assessment
Surface Water Standards & Guidance
Wastewater Technology
Water Infrastructure
What You Can Do

National Recommended Water Quality Criteria

EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.

You will need Adobe Reader to view some of the files on this page. See EPA's PDF page to learn more.

- Previous versions of National Recommended Water Quality Criteria Table
- Chemical-specific criteria documents from the 1980s
- Water quality standards
- Human Health Criteria Calculation Matrix (PDF) (23 pp, 445K)

Aquatic Life Criteria Table
Human Health Criteria Table
Organoleptic Effects (e.g., taste and odor)
Additional Notes

- Appendix A—Conversion Factors for Dissolved Metals
- Appendix B—Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent
- Appendix C—Calculation of Freshwater Ammonia Criterion
- Gold & Red Books

Aquatic Life Criteria Table

			Freshwater		Saltwater		
Pollutant	CAS Number	P/NP*	CMC [1] (acute) (µg/L)	CCC [1] (chronic) (µg/L)	CMC [1] (acute) (µg/L)	CCC [1] (chronic) (µg/L)	Publication Year
Acrolein	107028	P	3ug/L	3ug/L			2009
Aesthetic Qualities	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Aldrin	309002	P	3.0 G		1.3 G		1980
Alkalinity	—	NP		20000 C			1986
alpha-Endosulfan	959988	P	0.22 G, Y	0.056 G, Y	0.034 G, Y	0.0087 G, Y	1980
Aluminum pH 6.5 - 9.0	7429905	NP	750 I	87 I, S			1988
Ammonia	7664417	NP	FRESHWATER CRITERIA ARE pH, Temperature and Life-stage DEPENDENT SALTWATER CRITERIA ARE pH AND TEMPERATURE DEPENDENT				1999
Arsenic	7440382	P	340 A, D	150 A, D	69 A, D	36 A, D	1995

Bacteria	—	NP	FOR PRIMARY RECREATION AND SHELLFISH USES—SEE DOCUMENT				1986
beta-Endosulfan	33213659	P	0.22 G, Y	0.056 G, Y	0.034 G, Y	0.0087 G, Y	1980
Boron	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Carbaryl	63252	NP	2.1	2.1	1.6		2012
Cadmium	7440439	P	2.0 D, E	0.25 D, E	40 D	8.8 D	2001
Chlordane	57749	P	2.4 G	0.0043 G	0.09 G	0.004 G	1980
Chloride	16887006	NP	860000	230000			1986
Chlorine	7782505	NP	19	11	13	7.5	1986
Chloropyrifos	2921882	NP	0.083	0.041	0.011	0.0056	1986
Chromium (III)	16065831	P	570 D, E	74 D, E			1995
Chromium (VI)	18540299	P	16 D	11 D	1,100 D	50 D	1995
Color	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Copper	7440508	P	Freshwater criteria calculated using the BLM mm - See Document		4.8 D, cc	3.1 D, cc	2007
Cyanide	57125	P	22 Q	5.2 Q	1 Q	1 Q	1985
Demeton	8065483	NP		0.1 C		0.1 C	1985
Diazinon	333415	NP	0.17ug/L	0.17ug/L	0.82ug/L	0.82ug/L	2005
Dieldrin	60571	P	0.24	0.056 O	0.71 G	0.0019 G	1995
Endrin	72208	P	0.086	0.036 O	0.037 G	0.0023 G	1995
gamma-BHC (Lindane)	58899	P	0.95		0.16 G		1995
Gases, Total Dissolved	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Guthion	86500	NP		0.01 C		0.01 C	1986
Hardness	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Heptachlor	76448	P	0.52 G	0.0038 G	0.053 G	0.0036 G	1980
Heptachlor Epoxide	1024573	P	0.52 G, V	0.0038 G, V	0.053 G, V	0.0036 G, V	1981
Iron	7439896	NP		1000 C			1986
Lead	7439921	P	65 D, E	2.5 D, E	210 D	8.1 D	1980
Malathion	121755	NP		0.1 C		0.1 C	1986
Mercury Methylmercury	7439976 22967926	P	1.4 D, hh	0.77 D, hh	1.8 D, ee, hh	0.94 D, ee, hh	1995
Methoxychlor	72435	NP		0.03 C		0.03 C	1986
Mirex	2385855	NP		0.001 C		0.001 C	1986
Nickel	7440020	P	470 D, E	52 D, E	74 D	8.2 D	1995
Nonylphenol	84852153	NP	28ug/L	6.6ug/L	7ug/L	1.7ug/L	2005
Nutrients	—	NP	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional				

			criteria)				
Oil and Grease	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Oxygen, Dissolved Freshwater Oxygen, Dissolved Saltwater	7782447	NP	WARMWATER AND COLDWATER MATRIX—SEE DOCUMENT SALTWATER—SEE DOCUMENT				1986
Parathion	56382	NP	0.065 I	0.013 I			1995
Pentachlorophenol	87865	P	19 F	15 F	13	7.9	1995
pH	—	NP		6.5 - 9 C		6.5 - 8.5 C, P	1986
Phosphorus Elemental	7723140	NP					1986
Polychlorinated Biphenyls (PCBs)		P		0.014 N		0.03 N	
Selenium	7782492	P	L, R	5.0 R	290 D, dd	71 D, dd	1999
Silver	7440224	P	3.2 D, E		1.9 D		1980
Solids Suspended and Turbidity	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Sulfide-Hydrogen Sulfide	7783064	NP		2.0 C		2.0 C	1986
Tainting Substances	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Temperature	—	NP	SPECIES DEPENDENT CRITERIA—SEE DOCUMENT M				1986
Toxaphene	8001352	P	0.73	0.0002	0.21	0.0002	1986
Tributyltin (TBT)	—	NP	0.46	0.072	0.42	0.0074	2004
Zinc	7440666	P	120 D, E	120 D, E	90 D	81 D	1995
4,4'-DDT	50293	P	1.1 G, ii	0.001 G, ii	0.13 G, ii	0.001 G, ii	1980

*P/NP - Indicates either a Priority Pollutant (P) or a Non Priority Pollutant (NP).

Footnotes

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive. Please consult the criteria document for details.

C The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976). The CCC of 20mg/L is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25% of the natural level.

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated per the equation presented in the criteria document.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH. Values displayed in table correspond to a pH of 7.8.

G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (PDF) (153 pp, 7.3MB) (EPA 440/5-80-019), Chlordane (PDF) (68 pp, 3.1MB) (EPA 440/5-80-027), DDT (PDF) (175 pp, 8.3MB) (EPA 440/5-80-038), Endosulfan (PDF) (155 pp, 7.3MB) (EPA 440/5-80-046), Endrin (PDF) (103 pp, 4.6MB) (EPA 440/5-80-047), Heptachlor (PDF) (114 pp, 5.4MB) (EPA 440/5-80-052), Hexachlorocyclohexane (PDF) (109 pp, 4.8MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines (PDF) (104 pp, 3.3MB). If evaluation is to be done using an averaging period, the acute criteria values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

I This value for aluminum is expressed in terms of total recoverable metal in the water column.

J This value was derived using the GLI Guidelines (60 FR 15393-15399, March 23, 1995; 40CFR132 Appendix A); the differences between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. No decision concerning this criterion was affected by any considerations that are specific to the Great Lakes.

L The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 ug/l and 12.82 ug/l, respectively. However, based on findings from a February 2009 SETAC Pellston Workshop on Ecological Assessment of Selenium in the Aquatic Environment, diet is the primary pathway of selenium exposure to aquatic life, and traditional methods for predicting toxicity on the basis of exposure to dissolved concentrations are not appropriate for selenium. (To view a summary of the SETAC Pellston workshop including key findings visit http://www.setac.org/resource/resmgr/publications_and_resources/selsummary.pdf).

M U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA 600/3-77-061. National Technical Information Service, Springfield, VA.

N This criterion applies to total PCBs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

P According to page 181 of the Red Book:

For open ocean waters where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation or any case outside the range of 6.5 to 8.5. For shallow, highly productive coastal and estuarine areas where naturally occurring pH variations approach the lethal limits of some species, changes in pH should be avoided but in any case should not exceed the limits established for fresh water, i.e., 6.5-9.0.

Q This recommended water quality criterion is expressed as ug free cyanide (as CN)/L.

R EPA is in the process of updating this criterion to reflect the latest scientific information. As a result, this criterion might change substantially in the near future.

S There are three major reasons why the use of Water-Effect Ratios might be appropriate.

1. The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH = 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time.
2. In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide.
3. EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 g aluminum/L, when either total recoverable or dissolved is measured.

V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 µg/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (PDF) (144 pp, 6.4MB) (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ii This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

mm The available toxicity data, when evaluated using the procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that freshwater aquatic life should be protected if the 24-hour average and four-day average concentrations do not respectively exceed the acute and chronic criteria concentrations calculated by the Biotic Ligand Model.

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Human Health Criteria Table

			Human Health for the consumption of		
Pollutant	CAS Number	P/NP*	Water + Organism (µg/L)	Organism Only (µg/L)	Publication Year
Acenaphthene	83329	P	670 B, U	990 B, U	2002
Acrolein	107028	P	6 ll	9 ll	2009
Acrylonitrile	107131	P	0.051 B, C	0.25 B, C	2002
Aldrin	309002	P	0.000049 B, C	0.000050 B, C	2002
alpha-BHC	319846	P	0.0026 B, C	0.0049 B, C	2002
alpha-Endosulfan	959988	P	62 B	89 B	2002
Anthracene	120127	P	8,300 B	40,000 B	2002
Antimony	7440360	P	5.6 B	640 B	2002
Arsenic	7440382	P	0.018 C, M, S	0.14 C, M, S	1992
Asbestos	1332214	P	7 million fibers/L I		1991
Barium	7440393	NP	1,000 A		1986

Benzene	71432	P	2.2 B, C	51 B, C	2002
Benzidine	92875	P	0.000086 B, C	0.00020 B, C	2002
Benzo(a) Anthracene	56553	P	0.0038 B, C	0.018 B, C	2002
Benzo(a) Pyrene	50328	P	0.0038 B, C	0.018 B, C	2002
Benzo(b) Fluoranthene	205992	P	0.0038 B, C	0.018 B, C	2002
Benzo(k) Fluoranthene	207089	P	0.0038 B, C	0.018 B, C	2002
Beryllium	7440417	P	Z		
beta-BHC	319857	P	0.0091 B, C	0.017 B, C	2002
beta-Endosulfan	33213659	P	62 B	89 B	2002
Bis(2-Chloroethyl) Ether	111444	P	0.030 B, C	0.53 B, C	2002
Bis(2-Chloroisopropyl) Ether	108601	P	1,400 B	65,000 B	2002
Bis(2-Ethylhexyl) Phthalate[X]	117817	P	1.2 B, C	2.2 B, C	2002
Bromoform	75252	P	4.3 B, C	140 B, C	2002
Butylbenzyl Phthalate[W]	85687	P	1,500 B	1,900 B	2002
Cadmium	7440439	P	Z		
Carbon Tetrachloride	56235	P	0.23 B, C	1.6 B, C	2002
Chlordane	57749	P	0.00080 B, C	0.00081 B, C	2002
Chlorobenzene	108907	P	130 Z, U	1,600 U	2003
Chlorodibromomethane	124481	P	0.40 B, C	13 B, C	2002
Chloroform	67663	P	5.7 C, P	470 C, P	2002
Chlorophenoxy Herbicide (2,4-D)	94757	NP	100 Z		1986
Chromium (III)	16065831	P	Z Total		
Chromium (VI)	18540299	P	Z Total		
Chrysene	218019	P	0.0038 B, C	0.018 B, C	2002
Copper	7440508	P	1,300 U		1992
Cyanide	57125	P	140 jj	140 jj	2003
Dibenzo(a,h)Anthracene	53703	P	0.0038 B, C	0.018 B, C	2002
Dichlorobromomethane	75274	P	0.55 B, C	17 B,C	2002
Dieldrin	60571	P	0.000052 B, C	0.000054 B, C	2002
Diethyl Phthalate[W]	84662	P	17,000 B	44,000 B	2002
Dimethyl Phthalate[W]	131113	P	270,000	1,100,000	2002
Di-n-Butyl Phthalate[W]	84742	P	2,000 B	4,500 B	2002
Dinitrophenols	25550587	NP	69	5300	2002
Endosulfan Sulfate	1031078	P	62 B	89 B	2002
Endrin	72208	P	0.059	0.060	2003
Endrin Aldehyde	7421934	P	0.29 B	0.30 B, H	2002
Ether, Bis(Chloromethyl)	542881	NP	0.00010 C	0.00029 C	2002
Ethylbenzene	100414	P	530	2,100	2003
Fluoranthene	206440	P	130 B	140 B	2002

Fluorene	86737	P	1,100 B	5,300 B	2002
gamma-BHC (Lindane)	58899	P	0.98	1.8	2003
Heptachlor	76448	P	0.000079 B, C	0.000079 B, C	2002
Heptachlor Epoxide	1024573	P	0.000039 B, C	0.000039 B, C	2002
Hexachlorobenzene	118741	P	0.00028 B, C	0.00029 B, C	2002
Hexachlorobutadiene	87683	P	0.44 B, C	18 B, C	2002
Hexachlorocyclo-hexane-Technical	608731		0.0123 H	0.0414H	
Hexachlorocyclopentadiene	77474	P	40 U	1,100 U	2003
Hexachloroethane	67721	P	1.4 B, C	3.3 B, C	2002
Ideno(1,2,3-cd)Pyrene	193395	P	0.0038 B, C	0.018 B, C	2002
Isophorone	78591	P	35 B, C	960 B, C	2002
Manganese	7439965	NP	50 O	100 A	
Methylmercury	22967926	P		0.3 mg/kg J	2001
Methoxychlor	72435	NP	100 A, Z		1986
Methyl Bromide	74839	P	47 B	1,500 B	2002
Methylene Chloride	75092	P	4.6 B, C	590 B,C	2002
Nickel	7440020	P	610 B	4,600 B	1998
Nitrates	14797558	NP	10,000 A		1986
Nitrobenzene	98953	P	17 B	690 B, H, U	2002
Nitrosamines	—	NP	0.0008	1.24	1980
Nitrosodibutylamine, N	924163	NP	0.0063 C	0.22 C	2002
Nitrosodiethylamine, N	55185	NP	0.0008 C	1.24 C	2002
Nitrosopyrrolidine, N	930552	NP	0.016 C	34 C	2002
N-Nitrosodimethylamine	62759	P	0.00069 B, C	3.0 B, C	2002
N-Nitrosodi-n-Propylamine	621647	P	0.0050 B, C	0.51 B, C	2002
N-Nitrosodiphenylamine	86306	P	3.3 B, C	6.0 B, C	2002
Nutrients	—	NP	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)		
Pentachlorobenzene	608935	NP	1.4 E	1.5 E	2002
Pentachlorophenol	87865	P	0.27 B, C	3.0 B, C, H	2002
pH	—	NP	5 - 9		1986
Phenol	108952	P	10,000 II, U	860,000 II, U	2009
Polychlorinated Biphenyls (PCBs)		P	0.000064 B, C, N	0.000064 B, C, N	2002
Pyrene	129000	P	830 B	4,000 B	2002
Selenium	7782492	P	170 Z	4200	2002
Solids Dissolved and Salinity	—	NP	250,000 A		1986
Tetrachlorobenzene,1,2,4,5-	95943	NP	0.97 B	1.1 B	2002
Tetrachloroethylene	127184	P	0.69 C	3.3 C	2002

Thallium	7440280	P	0.24	0.47	2003
Toluene	108883	P	1,300 Z	15,000	2003
Toxaphene	8001352	P	0.00028 B, C	0.00028 B, C	2002
Trichloroethylene	79016	P	2.5 C	30 C	2002
Trichlorophenol,2,4,5-	95954	NP	1,800 B	3,600 B	2002
Vinyl Chloride	75014	P	0.025 C, kk	2.4 C, kk	2003
Zinc	7440666	P	7,400 U	26,000 U	2002
1,1,1-Trichloroethane	71556	P	Z		
1,1,2,2-Tetrachloroethane	79345	P	0.17 B, C	4.0 B, C	2002
1,1,2-Trichloroethane	79005	P	0.59 B, C	16 B, C	2002
1,1-Dichloroethylene	75354	P	330	7,100	2003
1,2,4-Trichlorobenzene	120821	P	35	70	2003
1,2-Dichlorobenzene	95501	P	420	1,300	2003
1,2-Dichloroethane	107062	P	0.38 B, C	37 B, C	2002
1,2-Dichloropropane	78875	P	0.50 B, C	15 B, C	2002
1,2-Diphenylhydrazine	122667	P	0.036 B, C	0.20 B, C	2002
1,2-Trans-Dichloroethylene	156605	P	140 Z	10,000	2003
1,3-Dichlorobenzene	541731	P	320	960	2002
1,3-Dichloropropene	542756	P	0.34 C	21 C	2003
1,4-Dichlorobenzene	106467	P	63	190	2003
2,3,7,8-TCDD (Dioxin)	1746016	P	5.0E-9 C	5.1E-9 C	2002
2,4,6-Trichlorophenol	88062	P	1.4 B, C	2.4 B, C, U	2002
2,4-Dichlorophenol	120832	P	77 B, U	290 B, U	2002
2,4-Dimethylphenol	105679	P	380 B	850 B, U	2002
2,4-Dinitrophenol	51285	P	69 B	5,300 B	2002
2,4-Dinitrotoluene	121142	P	0.11 C	3.4 C	2002
2-Chloronaphthalene	91587	P	1,000 B	1,600 B	2002
2-Chlorophenol	95578	P	81 B, U	150 B, U	2002
2-Methyl-4,6-Dinitrophenol	534521	P	13	280	2002
3,3'-Dichlorobenzidine	91941	P	0.021 B, C	0.028 B, C	2002
3-Methyl-4-Chlorophenol	59507	P	U	U	
4,4'-DDD	72548	P	0.00031 B, C	0.00031 B, C	2002
4,4'-DDE	72559	P	0.00022 B, C	0.00022 B, C	2002
4,4'-DDT	50293	P	0.00022 B, C	0.00022 B, C	2002

*P/NP - Indicates either a Priority Pollutant (P) or a Non Priority Pollutant (NP).

Footnotes

A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document used to derive the original criterion was retained in each case.

C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

D According to the procedures described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, except possibly where a very sensitive species is important at a site, freshwater aquatic life should be protected if both conditions specified in Appendix C to the Preamble-Calculation of Freshwater Ammonia Criterion are satisfied.

F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).

H No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.

I This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

J This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

M EPA is currently reassessing the criteria for arsenic.

N This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O This criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.

P Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.

R U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA 600/3-77-061. National Technical Information Service, Springfield, VA.

S This recommended water quality criterion for arsenic refers to the inorganic form only.

T U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003. National Technical Information Service, Springfield, VA.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

Z A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.

jj This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., $Fe_4[Fe(CN)_6]_3$), this criterion may be over conservative.

kk This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

ll This criterion has been revised to reflect the Environmental Protection Agency's cancer slope factor (CSF) or reference dose (RfD), as contained in the Integrated Risk Information System (IRIS) as of (date of publication of Final FR Notice). The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in

each case.

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Organoleptic Effects (e.g., taste and odor)

Pollutant	CAS Number	Organoleptic Effect Criteria (µg/L)	FR Cite/ Source
Acenaphthene	83329	20	Gold Book
Color		NP	Gold Book
Iron	7439896	NP	Gold Book
Monochlorobenzene	108907	20	Gold Book
Tainting Substance		NP	Gold Book
3-Chlorophenol	—	0.1	Gold Book
4-Chlorophenol	106489	0.1	Gold Book
2,3-Dichlorophenol	—	0.04	Gold Book
2,5-Dichlorophenol	—	0.5	Gold Book
2,6-Dichlorophenol	—	0.2	Gold Book
3,4-Dichlorophenol	—	0.3	Gold Book
2,4,5-Trichlorophenol	95954	1	Gold Book
2,4,6-Trichlorophenol	88062	2	Gold Book
2,3,4,6-Tetrachlorophenol	—	1	Gold Book
2-Methyl-4-Chlorophenol	—	1800	Gold Book
3-Methyl-4-Chlorophenol	59507	3000	Gold Book
3-Methyl-6-Chlorophenol	—	20	Gold Book
2-Chlorophenol	95578	0.1	Gold Book
Copper	7440508	1000	Gold Book
2,4-Dichlorophenol	120832	0.3	Gold Book
2,4-Dimethylphenol	105679	400	Gold Book
Hexachlorocyclopentadiene	77474	1	Gold Book
Manganese	7439965		
Nitrobenzene	98953	30	Gold Book
Pentachlorophenol	87865	30	Gold Book
Phenol	108952	300	Gold Book
Zinc	7440666	5000	45 FR79341

Notes:

1. These criteria are based on organoleptic (taste and odor) effects. Because of variations in chemical nomenclature systems, this listing of pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

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Additional Notes

1. Criteria Maximum Concentration and Criterion Continuous Concentration

   The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

2. Criteria Recommendations for Priority Pollutants, Non Priority Pollutants and Organoleptic Effects

   This compilation lists all priority toxic pollutants and some non priority toxic pollutants, and both human health effect and organoleptic effect criteria issued pursuant to CWA §304(a). Blank spaces indicate that EPA has no CWA §304(a) criteria recommendations. For a number of non-priority toxic pollutants not listed, CWA §304(a) "water + organism" human health criteria are not available, but EPA has published MCLs under the SDWA that may be used in establishing water quality standards to protect water supply designated uses. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service CAS registry numbers, which provide a unique identification for each chemical.

3. Human Health Risk

   The human health criteria for the priority and non priority pollutants are based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

4. Water Quality Criteria published pursuant to Section 304(a) or Section 303(c) of the CWA

   Many of the values in the compilation were published in the California Toxics Rule. Although such values were published pursuant to Section 303(c) of the CWA, they represent the Agency's most recent calculation of water quality criteria and are thus the Agency's 304(a) criteria.

5. Calculation of Dissolved Metals Criteria

   The 304(a) criteria for metals, shown as dissolved metals, are calculated in one of two ways. For freshwater metals criteria that are hardness-dependent, the dissolved metal criteria were calculated using a hardness of 100 mg/l as CaCO3 for illustrative purposes only. Saltwater and freshwater metals' criteria that are not hardness-dependent are calculated by multiplying the total recoverable criteria before rounding by the appropriate conversion factors. The final dissolved metals' criteria in the table are rounded to two significant figures. Information regarding the calculation of hardness dependent conversion factors are included in the footnotes.

6. Maximum Contaminant Levels

   The compilation includes footnotes for pollutants with Maximum Contaminant Levels (MCLs) more stringent than the recommended water quality criteria in the compilation. MCLs for these pollutants are not included in the compilation, but can be found in the appropriate drinking water regulations (40 CFR 141.11-16 and 141.60-63), or can be accessed through the Safe Drinking Water Hotline (800-426-4791) or online.

7. Organoleptic Effects

   The compilation contains 304(a) criteria for pollutants with toxicity-based criteria as well as non-toxicity based criteria. The basis for the non-toxicity based criteria are organoleptic effects (e.g., taste and odor) which would make water and edible aquatic life unpalatable but not toxic to humans. The table includes criteria for organoleptic effects for 23 pollutants. Pollutants with organoleptic effect criteria more stringent than the criteria based on toxicity (e.g., included in both the priority and non-priority pollutant tables) are footnoted as such.

8. Gold Book

The "Gold Book" is Quality Criteria for Water: 1986. EPA 440/5-86-001.

9. Correction of Chemical Abstract Services Number

The Chemical Abstract Services number (CAS) for Bis(2-Chlorisoprpyl) Ether, has been revised in IRIS and in the table. The correct CAS number for this chemical is 108-60-1. The previous CAS number for this pollutant was 39638-32-9.

10. Contaminants with Blanks

EPA has not calculated criteria for contaminants with blanks. However, permit authorities should address these contaminants in NPDES permit actions using the States' existing narrative criteria for toxics.

11. Specific Chemical Calculations

Selenium—Aquatic Life
This compilation contains aquatic life criteria for selenium that are the same as those published in the proposed CTR. In the CTR, EPA proposed an acute criterion for selenium based on the criterion proposed for selenium in the Water Quality Guidance for the Great Lakes System (61 FR 58444). The GLI and CTR proposals take into account data showing that selenium's two prevalent oxidation states in water, selenite and selenate, present differing potentials for aquatic toxicity, as well as new data indicating that various forms of selenium are additive. The new approach produces a different selenium acute criterion concentration, or CMC, depending upon the relative proportions of selenite, selenate, and other forms of selenium that are present. EPA is currently undertaking a reassessment of selenium, and expects the 304(a) criteria for selenium will be revised based on the final reassessment (63 FR 26186). However, until such time as revised water quality criteria for selenium are published by the Agency, the recommended water quality criteria in this compilation are EPA's current 304(a) criteria.

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Appendix A—Conversion Factors for Dissolved Metals

Metal	Conversion Factor			
	freshwater CMC	freshwater CCC	saltwater CMC	saltwater CCC[1]
Arsenic	1.000	1.000	1.000	1.000
Cadmium	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]	0.994	0.994
Chromium III	0.316	0.860	—	—
Chromium VI	0.982	0.962	0.993	0.993
Copper	0.960	0.960	0.83	0.83
Lead	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]	0.951	0.951
Mercury	0.85	0.85	0.85	0.85
Nickel	0.998	0.997	0.990	0.990
Selenium	—	—	0.998	0.998
Silver	0.85	—	0.85	—
Zinc	0.978	0.986	0.946	0.946

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Appendix B—Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(*ln*hardness)(0.041838)]	1.101672-[(*ln*hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(*ln*hardness)(0.145712)]	1.46203-[(*ln*hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	—	—	0.85	—
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependant metals' criteria may be calculated from the following:

CMC (dissolved) = $\exp\{m_A [ln(\text{hardness})] + b_A\}$ (CF)

CCC (dissolved) = $\exp\{m_C [ln(\text{hardness})] + b_C\}$ (CF)

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Appendix C - Calculation of Freshwater Ammonia Criterion

1. The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations:

   - Where salmonid fish are present:
     - $CMC = (0.275/(1 + 10^{7.204-pH})) + (39.0/(1 + 10^{pH-7.204}))$
   - Or where salmonid fish are not present:
     - $CMC = (0.411/(1 + 10^{7.204-pH})) + (58.4/(1 + 10^{pH-7.204}))$

2.A. The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on theaverage, the CCC (chronic criterion) calculated using the following equations:

   - When fish early life stages are present:
     - $CCC = ((0.0577/(1 + 10^{7.688-pH})) + (2.487/(1 + 10^{pH-7.688}))) \times MIN(2.85, 1.45 \cdot 10^{0.028 \cdot (25-T)})$
   - When fish early life stages are absent:
     - $CCC = ((0.0577/(1 + 10^{7.688-pH})) + (2.487/(1 + 10^{pH-7.688}))) \times 1.45 \cdot 10^{0.028 \cdot (25-MAX(T,7))}$

B. In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.

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The Gold Book

Quality Criteria for Water, 1986 (PDF) (477 pp., 4.6 MB) May 1986

The Red Book

Quality Criteria for Water, 1976 (PDF) (534 pp., 6.2 MB) July 1976

Chemical Specific Criteria Documents from the 1980s

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USEPA RSLs, Summary Table
(Composite Table) (May 2013)

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information												Contaminant		Screening Levels											Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
1.8E-02	C	5.1E-06	C	1.5E-01	I					1	0.1		ALAR	1596-84-5	2.7E+01	c	9.6E+01	c	4.8E-01	c	2.4E+00	c	3.7E+00	c		8.2E-04	
8.7E-03	I			4.0E-03	I					1	0.1		Acephate	30560-19-1	5.6E+01	c**	2.0E+02	c*					7.7E+00	c**		1.7E-03	
		2.2E-06	I			9.0E-03	I	V		1		1.1E+05	Acetaldehyde	75-07-0	1.0E+01	c**	5.2E+01	c**	1.1E+00	c**	5.6E+00	c**	2.2E+00	c**		4.5E-04	
				2.0E-02	I					1	0.1		Acetochlor	34256-82-1	1.2E+03	n	1.2E+04	n					2.7E+02	n		2.2E-01	
				9.0E-01	I	3.1E+01	A	V		1		1.1E+05	Acetone	67-64-1	6.1E+04	n	6.3E+05	nms	3.2E+04	n	1.4E+05	n	1.2E+04	n		2.4E+00	
						2.0E-03	X	V		1		1.1E+05	Acetone Cyanohydrin	75-86-5	5.3E+01	n	2.2E+02	n	2.1E+00	n	8.8E+00	n	4.2E+00	n		8.4E-04	
						6.0E-02	I	V		1		1.3E+05	Acetonitrile	75-05-8	8.7E+02	n	3.7E+03	n	6.3E+01	n	2.6E+02	n	1.3E+02	n		2.6E-02	
				1.0E-01	I			V		1		2.5E+03	Acetophenone	98-86-2	7.8E+03	ns	1.0E+05	nms					1.5E+03	n		4.5E-01	
3.8E+00	C	1.3E-03	C							1	0.1		Acetylaminofluorene, 2-	53-96-3	1.3E-01	c	4.5E-01	c	1.9E-03	c	9.4E-03	c	1.3E-02	c		6.2E-05	
				5.0E-04	I	2.0E-05	I	V		1		2.3E+04	Acrolein	107-02-8	1.5E-01	n	6.5E-01	n	2.1E-02	n	8.8E-02	n	4.1E-02	n		8.4E-06	
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	1	0.1		Acrylamide	79-06-1	2.3E-01	c	3.4E+00	c	9.6E-03	c	1.2E-01	c	4.3E-02	c		9.1E-06	
				5.0E-01	I	1.0E-03	I			1	0.1		Acrylic Acid	79-10-7	3.0E+04	n	2.9E+05	nm	1.0E+00	n	4.4E+00	n	7.7E+03	n		1.6E+00	
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		1		1.1E+04	Acrylonitrile	107-13-1	2.4E-01	c*	1.2E+00	c*	3.6E-02	c*	1.8E-01	c*	4.5E-02	c*		9.8E-06	
						6.0E-03	P			1	0.1		Adiponitrile	111-69-3	8.5E+06	nm	3.6E+07	nm	6.3E+00	n	2.6E+01	n					
5.6E-02	C			1.0E-02	I					1	0.1		Alachlor	15972-60-8	8.7E+00	c*	3.1E+01	c					9.1E-01	c	2.0E+00	7.5E-04	1.6E-03
				1.0E-03	I					1	0.1		Aldicarb	116-06-3	6.1E+01	n	6.2E+02	n					1.5E+01	n	3.0E+00	3.8E-03	7.5E-04
				1.0E-03	I					1	0.1		Aldicarb Sulfone	1646-88-4	6.1E+01	n	6.2E+02	n					1.6E+01	n	2.0E+00	3.4E-03	4.4E-04
										1	0.1		Aldicarb sulfoxide	1646-87-3											4.0E+00		8.8E-04
1.7E+01	I	4.9E-03	I	3.0E-05	I					1	0.1		Aldrin	309-00-2	2.9E-02	c*	1.0E-01	c	5.0E-04	c	2.5E-03	c	4.0E-03	c		6.5E-04	
				2.5E-01	I					1	0.1		Ally	74223-64-6	1.5E+04	n	1.5E+05	nm					3.8E+03	n		1.5E+00	
				5.0E-03	I	1.0E-04	X			1	0.1		Allyl Alcohol	107-18-6	3.0E+02	n	3.1E+03	n	1.0E-01	n	4.4E-01	n	7.8E+01	n		1.6E-02	
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1		1.4E+03	Allyl Chloride	107-05-1	6.8E-01	c**	3.4E+00	c**	4.1E-01	c**	2.0E+00	c**	6.3E-01	c**		2.0E-04	
				1.0E+00	P	5.0E-03	P			1			Aluminum	7429-90-5	7.7E+04	n	9.9E+05	nm	5.2E+00	n	2.2E+01	n	1.6E+04	n		2.3E+04	
				4.0E-04	I					1			Aluminum Phosphide	20859-73-8	3.1E+01	n	4.1E+02	n					6.2E+00	n			
				3.0E-04	I					1	0.1		Amdro	67485-29-4	1.8E+01	n	1.8E+02	n					4.6E+00	n		1.7E+03	
				9.0E-03	I					1	0.1		Ametryn	834-12-8	5.5E+02	n	5.5E+03	n					1.2E+02	n		1.2E-01	
2.1E+01	C	6.0E-03	C							1	0.1		Aminobiphenyl, 4-	92-67-1	2.3E-02	c	8.2E-02	c	4.1E-04	c	2.0E-03	c	2.6E-03	c		1.3E-05	
				8.0E-02	P					1	0.1		Aminophenol, m-	591-27-5	4.9E+03	n	4.9E+04	n					1.2E+03	n		4.7E-01	
				2.0E-02	P					1	0.1		Aminophenol, p-	123-30-8	1.2E+03	n	1.2E+04	n					3.1E+02	n		1.2E-01	
				2.5E-03	I					1	0.1		Amitraz	33089-61-1	1.5E+02	n	1.5E+03	n					5.9E+00	n		3.0E+00	
						1.0E-01	I			1			Ammonia	7664-41-7					1.0E+02	n	4.4E+02	n					
				2.0E-01	I					1			Ammonium Sulfamate	7773-06-0	1.6E+04	n	2.0E+05	nm					3.1E+03	n			
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			1	0.1		Aniline	62-53-3	8.5E+01	c**	3.0E+02	c*	1.0E+00	n	4.4E+00	n	1.2E+01	c**		3.9E-03	
4.0E-02	P			2.0E-03	X					1	0.1		Anthraquinone, 9,10-	84-65-1	1.2E+01	c*	4.3E+01	c*					1.2E+00	c*		1.2E-02	
				4.0E-04	I					0.15			Antimony (metallic)	7440-36-0	3.1E+01	n	4.1E+02	n					6.0E+00	n	6.0E+00	2.7E-01	2.7E-01
				5.0E-04	H					0.15			Antimony Pentoxide	1314-60-9	3.9E+01	n	5.1E+02	n					7.5E+00	n			
				9.0E-04	H					0.15			Antimony Potassium Tartrate	11071-15-1	7.0E+01	n	9.2E+02	n					1.3E+01	n			
				4.0E-04	H					0.15			Antimony Tetroxide	1332-81-6	3.1E+01	n	4.1E+02	n					6.0E+00	n			
						2.0E-04	I			0.15			Antimony Trioxide	1309-64-4	2.8E+05	nm	1.2E+06	nm	2.1E-01	n	8.8E-01	n					
				1.3E-02	I					1	0.1		Apollo	74115-24-5	7.9E+02	n	8.0E+03	n					1.8E+02	n		1.1E+01	
2.5E-02	I	7.1E-06	I	5.0E-02	H					1	0.1		Aramite	140-57-8	1.9E+01	c	6.9E+01	c	3.4E-01	c	1.7E+00	c	1.1E+00	c		1.3E-02	
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			1	0.03		Arsenic, Inorganic	7440-38-2	6.1E-01	c*R	2.4E+00	cR	5.7E-04	c*	2.9E-03	c*	4.5E-02	c	1.0E+01	1.3E-03	2.9E-01
				3.5E-06	C	5.0E-05	I			1			Arsine	7784-42-1	2.7E-01	n	3.6E+00	n	5.2E-02	n	2.2E-01	n	5.4E-02	n			
				9.0E-03	I					1	0.1		Assure	76578-14-8	5.5E+02	n	5.5E+03	n					9.3E+01	n		1.4E+00	
				5.0E-02	I					1	0.1		Asulam	3337-71-1	3.1E+03	n	3.1E+04	n					7.8E+02	n		2.0E-01	
2.3E-01	C			3.5E-02	I					1	0.1		Atrazine	1912-24-9	2.1E+00	c	7.5E+00	c					2.6E-01	c	3.0E+00	1.7E-04	1.9E-03
8.8E-01	C	2.5E-04	C							1	0.1		Auramine	492-80-8	5.5E-01	c	2.0E+00	c	9.7E-03	c	4.9E-02	c	5.7E-02	c		5.2E-04	
				4.0E-04	I					1	0.1		Avermectin B1	65195-55-3	2.4E+01	n	2.5E+02	n					6.3E+00	n		1.1E+01	
1.1E-01	I	3.1E-05	I					V		1			Azobenzene	103-33-3	5.1E+00	c	2.3E+01	c	7.8E-02	c	4.0E-01	c	1.0E-01	c		8.0E-04	
				2.0E-01	I	5.0E-04	H			0.07			Barium	7440-39-3	1.5E+04	n	1.9E+05	nm	5.2E-01	n	2.2E+00	n	2.9E+03	n	2.0E+03	1.2E+02	8.2E+01
				4.0E-03	I					1	0.1		Baygon	114-26-1	2.4E+02	n	2.5E+03	n					6.1E+01	n		2.0E-02	
				3.0E-02	I					1	0.1		Bayleton	43121-43-3	1.8E+03	n	1.8E+04	n					4.3E+02	n		3.4E-01	
				2.5E-02	I					1	0.1		Baythroid	68359-37-5	1.5E+03	n	1.5E+04	n					8.7E+01	n		2.3E+01	
				3.0E-01	I					1	0.1		Benefin	1861-40-1	1.8E+04	n	1.8E+05	nm					1.2E+03	n		4.1E+01	
				5.0E-02	I					1	0.1		Benomyl	17804-35-2	3.1E+03	n	3.1E+04	n					7.5E+02	n		6.6E-01	
				3.0E-02	I					1	0.1		Bentazon	25057-89-0	1.8E+03	n	1.8E+04	n					4.4E+02	n		9.6E-02	
				1.0E-01	I			V		1		1.2E+03	Benzaldehyde	100-52-7	7.8E+03	ns	1.0E+05	nms					1.5E+03	n		3.3E-01	
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1		1.8E+03	Benzene	71-43-2	1.1E+00	c*	5.4E+00	c*	3.1E-01	c	1.6E+00	c*	3.9E-01	c*	5.0E+00	2.0E-04	2.6E-03
1.0E-01	X			3.0E-04	X					1	0.1		Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	4.9E+00	c**	1.7E+01	c*					6.7E-01	c**		1.9E-04	
				1.0E-03	P			V		1		1.3E+03	Benzenethiol	108-98-5	7.8E+01	n	1.0E+03	n					1.3E+01	n		8.6E-03	
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1	0.1		Benzidine	92-87-5	5.0E-04	c	7.5E-03	c	1.4E-05	c	1.8E-04	c	9.2E-05	c		2.4E-07	
				4.0E+00	I					1	0.1		Benzoic Acid	65-85-0	2.4E+05	nm	2.5E+06	nm					5.8E+04	n		1.4E+01	
1.3E+01	I							V		1		3.2E+02	Benzotrichloride	98-07-7	4.9E-02	c	2.2E-01	c					2.6E-03	c		5.6E-06	
				1.0E-01	P					1	0.1		Benzyl Alcohol	100-51-6	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.7E-01	
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1		1.5E+03	Benzyl Chloride	100-44-7	1.0E+00	c*	4.9E+00	c*	5.0E-02	c*	2.5E-01	c*	7.7E-02	c*		8.4E-05	

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Toxicity and Chemical-specific Information													Contaminant		Screening Levels										Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
		2.4E-03	I	2.0E-03	I	2.0E-05	I			0.007			Beryllium and compounds	7440-41-7	1.6E+02	n	2.0E+03	n	1.0E-03	c*	5.1E-03	c*	1.6E+01	n	4.0E+00	1.3E+01	3.2E+00
				1.0E-04	I					1	0.1		Bidrin	141-66-2	6.1E+00	n	6.2E+01	n					1.6E+00	n		3.6E-04	
				9.0E-03	P					1	0.1		Bifenox	42576-02-3	5.5E+02	n	5.5E+03	n					7.5E+01	n		5.7E-01	
				1.5E-02	I					1	0.1		Biphenthrin	82657-04-3	9.2E+02	n	9.2E+03	n					2.3E+02	n		1.1E+03	
8.0E-03	X			5.0E-02	I	4.0E-04	X	V		1			Biphenyl, 1,1'-	92-52-4	5.1E+01	n	2.1E+02	n	4.2E-01	n	1.8E+00	n	8.3E-01	n		8.7E-03	
7.0E-02	H	1.0E-05	H	4.0E-02	I			V		1		1.0E+03	Bis(2-chloro-1-methylethyl) ether	108-60-1	4.6E+00	c	2.2E+01	c	2.4E-01	c	1.2E+00	c	3.1E-01	c		1.1E-04	
				3.0E-03	P					1	0.1		Bis(2-chloroethoxy)methane	111-91-1	1.8E+02	n	1.8E+03	n					4.6E+01	n		1.1E-02	
1.1E+00	I	3.3E-04	I					V		1		5.1E+03	Bis(2-chloroethyl)ether	111-44-4	2.1E-01	c	1.0E+00	c	7.4E-03	c	3.7E-02	c	1.2E-02	c		3.1E-06	
1.4E-02	I	2.4E-06	C	2.0E-02	I					1	0.1		Bis(2-ethylhexyl)phthalate	117-81-7	3.5E+01	c*	1.2E+02	c	1.0E+00	c	5.1E+00	c	4.8E+00	c*	6.0E+00	1.1E+00	1.4E+00
2.2E+02	I	6.2E-02	I					V		1		4.2E+03	Bis(chloromethyl)ether	542-88-1	7.7E-05	c	3.9E-04	c	3.9E-05	c	2.0E-04	c	6.2E-05	c		1.5E-08	
				5.0E-02	I					1	0.1		Bisphenol A	80-05-7	3.1E+03	n	3.1E+04	n					5.8E+02	n		4.4E+01	
				2.0E-01	I	2.0E-02	H			1			Boron And Borates Only	7440-42-8	1.6E+04	n	2.0E+05	nm	2.1E+01	n	8.8E+01	n	3.1E+03	n		9.9E+00	
				2.0E+00	P	2.0E-02	P			1			Boron Trichloride	10294-34-5	1.6E+05	nm	2.0E+06	nm	2.1E+01	n	8.8E+01	n	3.1E+04	n			
				4.0E-02	C	1.3E-02	C			1			Boron Trifluoride	7637-07-2	3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	6.2E+02	n			
7.0E-01	I			4.0E-03	I					1			Bromate	15541-45-4	9.1E-01	c	4.1E+00	c					9.6E-02	c	1.0E+01	7.4E-04	7.7E-02
2.0E+00	X	6.0E-04	X					V		1		2.4E+03	Bromo-2-chloroethane, 1-	107-04-0	2.4E-02	c	1.2E-01	c	4.1E-03	c	2.0E-02	c	6.4E-03	c		1.8E-06	
				8.0E-03	I	6.0E-02	I	V		1		6.8E+02	Bromobenzene	108-86-1	3.0E+02	n	1.8E+03	ns	6.3E+01	n	2.6E+02	n	5.4E+01	n		3.6E-02	
						4.0E-02	X	V		1		4.0E+03	Bromochloromethane	74-97-5	1.6E+02	n	6.8E+02	n	4.2E+01	n	1.8E+02	n	8.3E+01	n		2.1E-02	
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		1		9.3E+02	Bromodichloromethane	75-27-4	2.7E-01	c	1.4E+00	c	6.6E-02	c	3.3E-01	c	1.2E-01	c	8.0E+01(F)	3.2E-05	2.2E-02
7.9E-03	I	1.1E-06	I	2.0E-02	I					1	0.1		Bromoform	75-25-2	6.2E+01	c*	2.2E+02	c*	2.2E+00	c	1.1E+01	c	7.9E+00	c*	8.0E+01(F)	2.1E-03	2.1E-02
				1.4E-03	I	5.0E-03	I	V		1		3.6E+03	Bromomethane	74-83-9	7.3E+00	n	3.2E+01	n	5.2E+00	n	2.2E+01	n	7.0E+00	n		1.8E-03	
				5.0E-03	H					1	0.1		Bromophos	2104-96-3	3.1E+02	n	3.1E+03	n					2.6E+01	n		1.1E-01	
				2.0E-02	I					1	0.1		Bromoxynil	1689-84-5	1.2E+03	n	1.2E+04	n					2.5E+02	n		2.2E-01	
				2.0E-02	I					1	0.1		Bromoxynil Octanoate	1689-99-2	1.2E+03	n	1.2E+04	n					1.0E+02	n		8.7E-01	
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1		6.7E+02	Butadiene, 1,3-	106-99-0	5.4E-02	c*	2.6E-01	c*	8.1E-02	c*	4.1E-01	c*	1.6E-02	c		8.6E-06	
				1.0E-01	I					1	0.1		Butanol, N-	71-36-3	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.2E-01	
1.9E-03	P			2.0E-01	I					1	0.1		Butyl Benzyl Phthlate	85-68-7	2.6E+02	c*	9.1E+02	c					1.4E+01	c*		2.0E-01	
				2.0E+00	P	3.0E+01	P			1	0.1		Butyl alcohol, sec-	78-92-2	1.2E+05	nm	1.2E+06	nm	3.1E+04	n	1.3E+05	n	3.1E+04	n		6.3E+00	
				5.0E-02	I					1	0.1		Butylate	2008-41-5	3.1E+03	n	3.1E+04	n					3.4E+02	n		3.3E-01	
2.0E-04	C	5.7E-08	C							1	0.1		Butylated hydroxyanisole	25013-16-5	2.4E+03	c	8.6E+03	c	4.3E+01	c	2.2E+02	c	2.1E+02	c		3.9E-01	
				5.0E-02	P			V		1		1.1E+02	Butylbenzene, n-	104-51-8	3.9E+03	ns	5.1E+04	ns					7.8E+02	n		2.5E+00	
				1.0E-01	X			V		1		1.5E+02	Butylbenzene, sec-	135-98-8	7.8E+03	ns	1.0E+05	nms					1.6E+03	n		4.6E+00	
				1.0E-01	X			V		1		1.8E+02	Butylbenzene, tert-	98-06-6	7.8E+03	ns	1.0E+05	nms					5.1E+02	n		1.1E+00	
				1.0E+00	I					1	0.1		Butylphthalyl Butylglycolate	85-70-1	6.1E+04	n	6.2E+05	nm					1.0E+04	n		2.3E+02	
				2.0E-02	A					1	0.1		Cacodylic Acid	75-60-5	1.2E+03	n	1.2E+04	n					3.1E+02	n			
		1.8E-03	I	1.0E-03	I	1.0E-05	A			0.025	0.001		Cadmium (Diet)	7440-43-9	7.0E+01	n	8.0E+02	n									
		1.8E-03	I	5.0E-04	I	1.0E-05	A			0.05	0.001		Cadmium (Water)	7440-43-9					1.4E-03	c**	6.8E-03	c**	6.9E+00	n	5.0E+00	5.2E-01	3.8E-01
				5.0E-01	I					1	0.1		Caprolactam	105-60-2	3.1E+04	n	3.1E+05	nm					7.7E+03	n		1.9E+00	
1.5E-01	C	4.3E-05	C	2.0E-03	I					1	0.1		Captafol	2425-06-1	3.2E+00	c*	1.1E+01	c	5.7E-02	c	2.9E-01	c	3.5E-01	c*		6.1E-04	
2.3E-03	C	6.6E-07	C	1.3E-01	I					1	0.1		Captan	133-06-2	2.1E+02	c*	7.5E+02	c	3.7E+00	c	1.9E+01	c	2.7E+01	c*		1.9E-02	
				1.0E-01	I					1	0.1		Carbaryl	63-25-2	6.1E+03	n	6.2E+04	n					1.4E+03	n		1.3E+00	
				5.0E-03	I					1	0.1		Carbofuran	1563-66-2	3.1E+02	n	3.1E+03	n					7.3E+01	n	4.0E+01	2.8E-02	1.6E-02
				1.0E-01	I	7.0E-01	I	V		1		7.4E+02	Carbon Disulfide	75-15-0	8.2E+02	ns	3.7E+03	ns	7.3E+02	n	3.1E+03	n	7.2E+02	n		2.1E-01	
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		1		4.6E+02	Carbon Tetrachloride	56-23-5	6.1E-01	c	3.0E+00	c	4.1E-01	c	2.0E+00	c	3.9E-01	c	5.0E+00	1.5E-04	1.9E-03
				1.0E-02	I					1	0.1		Carbosulfan	55285-14-8	6.1E+02	n	6.2E+03	n					3.7E+01	n		9.0E-01	
				1.0E-01	I					1	0.1		Carboxin	5234-68-4	6.1E+03	n	6.2E+04	n					1.5E+03	n		8.0E-01	
						9.0E-04	I			1			Ceric oxide	1306-38-3	1.3E+06	nm	5.4E+06	nm	9.4E-01	n	3.9E+00	n					
				1.0E-01	I					1	0.1		Chloral Hydrate	302-17-0	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.1E-01	
				1.5E-02	I					1	0.1		Chloramben	133-90-4	9.2E+02	n	9.2E+03	n					2.2E+02	n		5.5E-02	
4.0E-01	H									1	0.1		Chloranil	118-75-2	1.2E+00	c	4.3E+00	c					1.6E-01	c		1.3E-04	
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			1	0.04		Chlordane	12789-03-6	1.6E+00	c*	6.5E+00	c*	2.4E-02	c*	1.2E-01	c*	1.9E-01	c*	2.0E+00	1.3E-02	1.4E-01
1.0E+01	I	4.6E-03	C	3.0E-04	I					1	0.1		Chlordecone (Kepone)	143-50-0	4.9E-02	c	1.7E-01	c	5.3E-04	c	2.7E-03	c	3.0E-03	c		1.1E-04	
				7.0E-04	A					1	0.1		Chlorfenvinphos	470-90-6	4.3E+01	n	4.3E+02	n					8.6E+00	n		2.3E-02	
				2.0E-02	I					1	0.1		Chlorimuron, Ethyl-	90982-32-4	1.2E+03	n	1.2E+04	n					3.0E+02	n		1.0E-01	
				1.0E-01	I	1.5E-04	A			1			Chlorine	7782-50-5	7.5E+03	n	9.1E+04	n	1.5E-01	n	6.4E-01	n	1.6E+03	n		7.0E-01	
				3.0E-02	I	2.0E-04	I			1			Chlorine Dioxide	10049-04-4	2.3E+03	n	3.0E+04	n	2.1E-01	n	8.8E-01	n	4.7E+02	n			
				3.0E-02	I					1			Chlorite (Sodium Salt)	7758-19-2	2.3E+03	n	3.1E+04	n					4.7E+02	n	1.0E+03		
						5.0E+01	I	V		1		1.2E+03	Chloro-1,1-difluoroethane, 1-	75-68-3	5.8E+04	ns	2.4E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		5.2E+01	
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		1		7.5E+02	Chloro-1,3-butadiene, 2-	126-99-8	9.4E-03	c	4.7E-02	c	8.1E-03	c	4.1E-02	c	1.6E-02	c		8.5E-06	
4.6E-01	H									1	0.1		Chloro-2-methylaniline HCl, 4-	3165-93-3	1.1E+00	c	3.7E+00	c					1.5E-01	c		1.3E-04	
1.0E-01	P	7.7E-05	C	3.0E-03	X					1	0.1		Chloro-2-methylaniline, 4-	95-69-2	4.9E+00	c*	1.7E+01	c	3.2E-02	c	1.6E-01	c	6.0E-01	c*		3.4E-04	
2.7E-01	X							V		1	0.1	2.8E+04	Chloroacetaldehyde, 2-	107-20-0	1.8E+00	c	6.4E+00	c					2.5E-01	c		5.0E-05	
				2.0E-03	H					1	0.1		Chloroacetic Acid	79-11-8	1.2E+02	n	1.2E+03	n					3.1E+01	n	6.0E+01	6.3E-03	1.2E-02
						3.0E-05	I			1	0.1		Chloroacetophenone, 2-	532-27-4	4.3E+04	n	1.8E+05	nm	3.1E-02	n	1.3E-01	n					
2.0E-01	P			4.0E-03	I					1	0.1		Chloroaniline, p-	106-47-8	2.4E+00	c	8.6E+00	c					3.2E-01	c		1.3E-04	

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Toxicity and Chemical-specific Information													Contaminant		Screening Levels											Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-02	I	5.0E-02	P	V		1		7.6E+02	Chlorobenzene	108-90-7	2.9E+02	n	1.4E+03	ns	5.2E+01	n	2.2E+02	n	7.2E+01	n	1.0E+02	4.9E-02	6.8E-02
1.1E-01	C	3.1E-05	C	2.0E-02	I					1	0.1		Chlorobenzilate	510-15-6	4.4E+00	c	1.6E+01	c	7.8E-02	c	4.0E-01	c	2.7E-01	c		8.8E-04	
				3.0E-02	X					1	0.1		Chlorobenzoic Acid, p-	74-11-3	1.8E+03	n	1.8E+04	n					3.9E+02	n		9.9E-02	
				3.0E-03	P	3.0E-01	P	V		1		1.2E+02	Chlorobenzotrifluoride, 4-	98-56-6	2.1E+02	ns	2.3E+03	ns	3.1E+02	n	1.3E+03	n	2.6E+01	n		9.3E-02	
				4.0E-02	P			V		1		7.3E+02	Chlorobutane, 1-	109-69-3	3.1E+03	ns	4.1E+04	ns					4.8E+02	n		2.0E-01	
						5.0E+01	I	V		1		1.7E+03	Chlorodifluoromethane	75-45-6	5.3E+04	ns	2.2E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		4.3E+01	
				2.0E-02	P					1	0.1		Chloroethanol, 2-	107-07-3	1.2E+03	n	1.2E+04	n					3.1E+02	n		6.3E-02	
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1		2.5E+03	Chloroform	67-66-3	2.9E-01	c	1.5E+00	c	1.1E-01	c	5.3E-01	c	1.9E-01	c	8.0E+01(F)	5.3E-05	2.2E-02
						9.0E-02	I	V		1		1.3E+03	Chloromethane	74-87-3	1.2E+02	n	5.0E+02	n	9.4E+01	n	3.9E+02	n	1.9E+02	n		4.9E-02	
2.4E+00	C	6.9E-04	C					V		1		2.6E+04	Chloromethyl Methyl Ether	107-30-2	1.9E-02	c	9.4E-02	c	3.5E-03	c	1.8E-02	c	5.6E-03	c		1.2E-06	
				8.0E-02	I			V		1			Chloronaphthalene, Beta-	91-58-7	6.3E+03	n	8.2E+04	n					5.5E+02	n		2.9E+00	
3.0E-01	P			3.0E-03	P	1.0E-05	X			1	0.1		Chloronitrobenzene, o-	88-73-3	1.6E+00	c	5.7E+00	c	1.0E-02	n	4.4E-02	n	2.0E-01	c		1.9E-04	
6.3E-03	P			1.0E-03	P	6.0E-04	P			1	0.1		Chloronitrobenzene, p-	100-00-5	6.1E+01	n	2.7E+02	c**	6.3E-01	n	2.6E+00	n	9.4E+00	c**		8.7E-03	
				5.0E-03	I			V		1		2.2E+04	Chlorophenol, 2-	95-57-8	3.9E+02	n	5.1E+03	n					7.1E+01	n		5.7E-02	
						4.0E-04	C	V		1		6.2E+02	Chloropicrin	76-06-2	2.1E+00	n	8.8E+00	n	4.2E-01	n	1.8E+00	n	8.3E-01	n		2.5E-04	
3.1E-03	C	8.9E-07	C	1.5E-02	I					1	0.1		Chlorothalonil	1897-45-6	1.6E+02	c**	5.6E+02	c*	2.7E+00	c	1.4E+01	c	1.9E+01	c*		4.3E-02	
				2.0E-02	I			V		1		9.1E+02	Chlorotoluene, o-	95-49-8	1.6E+03	ns	2.0E+04	ns					1.8E+02	n		1.7E-01	
				2.0E-02	X			V		1		2.5E+02	Chlorotoluene, p-	106-43-4	1.6E+03	ns	2.0E+04	ns					1.9E+02	n		1.8E-01	
2.4E+02	C	6.9E-02	C							1	0.1		Chlorozotocin	54749-90-5	2.0E-03	c	7.2E-03	c	3.5E-05	c	1.8E-04	c	2.8E-04	c		6.2E-08	
				2.0E-01	I					1	0.1		Chlorpropham	101-21-3	1.2E+04	n	1.2E+05	nm					2.2E+03	n		1.9E+00	
				1.0E-03	A					1	0.1		Chlorpyrifos	2921-88-2	6.1E+01	n	6.2E+02	n					6.2E+00	n		9.2E-02	
				1.0E-02	H					1	0.1		Chlorpyrifos Methyl	5598-13-0	6.1E+02	n	6.2E+03	n					8.9E+01	n		4.1E-01	
				5.0E-02	I					1	0.1		Chlorsulfuron	64902-72-3	3.1E+03	n	3.1E+04	n					7.7E+02	n		6.5E-01	
				8.0E-04	H					1	0.1		Chlorthiophos	60238-56-4	4.9E+01	n	4.9E+02	n					2.0E+00	n		5.2E-02	
				1.5E+00	I					0.013			Chromium(III), Insoluble Salts	16065-83-1	1.2E+05	nm	1.5E+06	nm					1.6E+04	n		2.8E+07	
5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I		M	0.025			Chromium(VI)	18540-29-9	2.9E-01	c	5.6E+00	c	1.1E-05	c	1.5E-04	c	3.1E-02	c		5.9E-04	
										0.013			Chromium, Total	7440-47-3											1.0E+02		1.8E+05
		9.0E-03	P	3.0E-04	P	6.0E-06	P			1			Cobalt	7440-48-4	2.3E+01	n	3.0E+02	n	2.7E-04	c*	1.4E-03	c*	4.7E+00	n		2.1E-01	
		6.2E-04	I						M	1	0.1		Coke Oven Emissions	8007-45-2					1.5E-03	c	2.0E-02	c					
				4.0E-02	H					1			Copper	7440-50-8	3.1E+03	n	4.1E+04	n					6.2E+02	n	1.3E+03	2.2E+01	4.6E+01
				5.0E-02	I	6.0E-01	C			1	0.1		Cresol, m-	108-39-4	3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	7.2E+02	n		5.7E-01	
				5.0E-02	I	6.0E-01	C			1	0.1		Cresol, o-	95-48-7	3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	7.2E+02	n		5.8E-01	
				1.0E-01	A	6.0E-01	C			1	0.1		Cresol, p-	106-44-5	6.1E+03	n	6.2E+04	n	6.3E+02	n	2.6E+03	n	1.4E+03	n		1.1E+00	
				1.0E-01	A					1	0.1		Cresol, p-chloro-m-	59-50-7	6.1E+03	n	6.2E+04	n					1.1E+03	n		1.3E+00	
				1.0E-01	A	6.0E-01	C			1	0.1		Cresols	1319-77-3	6.1E+03	n	6.2E+04	n	6.3E+02	n	2.6E+03	n	1.4E+03	n		1.2E+00	
1.9E+00	H			1.0E-03	P			V		1		1.7E+04	Crotonaldehyde, trans-	123-73-9	3.4E-01	c	1.5E+00	c					3.5E-02	c		7.1E-06	
				1.0E-01	I	4.0E-01	I	V		1		2.7E+02	Cumene	98-82-8	2.1E+03	ns	1.1E+04	ns	4.2E+02	n	1.8E+03	n	3.9E+02	n		6.4E-01	
2.2E-01	C	6.3E-05	C							1	0.1		Cupferron	135-20-6	2.2E+00	c	7.8E+00	c	3.9E-02	c	1.9E-01	c	3.1E-01	c		5.3E-04	
8.4E-01	H			2.0E-03	H					1	0.1		Cyanazine	21725-46-2	5.8E-01	c	2.1E+00	c					7.6E-02	c		3.5E-05	
													Cyanides														
				1.0E-03	I					1			~Calcium Cyanide	592-01-8	7.8E+01	n	1.0E+03	n					1.6E+01	n			
				5.0E-03	I					1			~Copper Cyanide	544-92-3	3.9E+02	n	5.1E+03	n					7.8E+01	n			
				6.0E-04	I	8.0E-04	S	V		1		1.0E+07	~Cyanide (CN-)	57-12-5	2.2E+01	n	1.4E+02	n	8.3E-01	n	3.5E+00	n	1.4E+00	n	2.0E+02	1.4E-02	2.0E+00
				1.0E-03	I			V		1			~Cyanogen	460-19-5	7.8E+01	n	1.0E+03	n					1.6E+01	n			
				9.0E-02	I			V		1			~Cyanogen Bromide	506-68-3	7.0E+03	n	9.2E+04	n					1.4E+03	n			
				5.0E-02	I			V		1			~Cyanogen Chloride	506-77-4	3.9E+03	n	5.1E+04	n					7.8E+02	n			
				6.0E-04	I	8.0E-04	I	V		1		1.0E+07	~Hydrogen Cyanide	74-90-8	2.3E+01	n	1.5E+02	n	8.3E-01	n	3.5E+00	n	1.4E+00	n		1.4E-02	
				2.0E-03	I					1			~Potassium Cyanide	151-50-8	1.6E+02	n	2.0E+03	n					3.1E+01	n			
				5.0E-03	I					0.04			~Potassium Silver Cyanide	506-61-6	3.9E+02	n	5.1E+03	n					5.9E+01	n			
				1.0E-01	I					0.04			~Silver Cyanide	506-64-9	7.8E+03	n	1.0E+05	nm					1.3E+03	n			
				1.0E-03	I					1			~Sodium Cyanide	143-33-9	7.8E+01	n	1.0E+03	n					1.6E+01	n	2.0E+02		
				2.0E-04	P					1			~Thiocyanates	NA	1.6E+01	n	2.0E+02	n					3.1E+00	n			
				2.0E-04	X					1			~Thiocyanic Acid	463-56-9									3.1E+00	n			
				5.0E-02	I					1			~Zinc Cyanide	557-21-1	3.9E+03	n	5.1E+04	n					7.8E+02	n			
						6.0E+00	I	V		1		1.2E+02	Cyclohexane	110-82-7	7.0E+03	ns	2.9E+04	ns	6.3E+03	n	2.6E+04	n	1.3E+04	n		1.3E+01	
2.3E-02	H									1	0.1		Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.1E+01	c	7.5E+01	c					2.1E+00	c		1.2E-02	
				5.0E+00	I	7.0E-01	P			1	0.1		Cyclohexanone	108-94-1	3.1E+05	nm	3.1E+06	nm	7.3E+02	n	3.1E+03	n	7.7E+04	n		1.8E+01	
				5.0E-03	P	1.0E+00	X	V		1		2.8E+02	Cyclohexene	110-83-8	3.1E+02	ns	2.8E+03	ns	1.0E+03	n	4.4E+03	n	5.3E+01	n		3.5E-02	
				2.0E-01	I					1	0.1		Cyclohexylamine	108-91-8	1.2E+04	n	1.2E+05	nm					3.0E+03	n		7.9E-01	
				5.0E-03	I					1	0.1		Cyhalothrin/karate	68085-85-8	3.1E+02	n	3.1E+03	n					7.8E+01	n		5.3E+01	
				1.0E-02	I					1	0.1		Cypermethrin	52315-07-8	6.1E+02	n	6.2E+03	n					1.6E+02	n		2.5E+01	
				7.5E-03	I					1	0.1		Cyromazine	66215-27-8	4.6E+02	n	4.6E+03	n					1.2E+02	n		3.0E-02	
2.4E-01	I	6.9E-05	C							1	0.1		DDD	72-54-8	2.0E+00	c	7.2E+00	c	3.5E-02	c	1.8E-01	c	2.7E-02	c		6.4E-03	
3.4E-01	I	9.7E-05	C							1	0.1		DDE, p,p'-	72-55-9	1.4E+00	c	5.1E+00	c	2.5E-02	c	1.3E-01	c	2.0E-01	c		4.6E-02	
3.4E-01	I	9.7E-05	I	5.0E-04	I					1	0.03		DDT	50-29-3	1.7E+00	c*	7.0E+00	c*	2.5E-02	c	1.3E-01	c	2.0E-01	c*		6.7E-02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vo c	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.0E-02	I					1	0.1		Dacthal	1861-32-1	6.1E+02	n	6.2E+03	n					9.3E+01	n		1.1E-01	
				3.0E-02	I					1	0.1		Dalapon	75-99-0	1.8E+03	n	1.8E+04	n					4.6E+02	n	2.0E+02	9.6E-02	4.1E-02
7.0E-04	I			7.0E-03	I					1	0.1		Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	4.3E+02	n	2.5E+03	c**					9.6E+01	c**		5.3E+01	
				4.0E-05	I					1	0.1		Demeton	8065-48-3	2.4E+00	n	2.5E+01	n					5.2E-01	n			
1.2E-03	I			6.0E-01	I					1	0.1		Di(2-ethylhexyl)adipate	103-23-1	4.1E+02	c*	1.4E+03	c					5.6E+01	c	4.0E+02	4.0E+00	2.9E+01
6.1E-02	H									1	0.1		Diallate	2303-16-4	8.0E+00	c	2.8E+01	c					4.6E-01	c		6.8E-04	
				7.0E-04	A					1	0.1		Diazinon	333-41-5	4.3E+01	n	4.3E+02	n					7.9E+00	n		4.9E-02	
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	1		9.8E+02	Dibromo-3-chloropropane, 1,2-	96-12-8	5.4E-03	c	6.9E-02	c	1.6E-04	c	2.0E-03	c	3.2E-04	c	2.0E-01	1.4E-07	8.6E-05
				1.0E-02	I					1	0.1		Dibromobenzene, 1,4-	106-37-6	6.1E+02	n	6.2E+03	n					9.8E+01	n		9.3E-02	
8.4E-02	I	2.7E-05	C	2.0E-02	I			V		1	0.1	8.0E+02	Dibromochloromethane	124-48-1	6.8E-01	c	3.3E+00	c	9.0E-02	c	4.5E-01	c	1.5E-01	c	8.0E+01(F)	3.9E-05	2.1E-02
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1		1.3E+03	Dibromoethane, 1,2-	106-93-4	3.4E-02	c	1.7E-01	c	4.1E-03	c	2.0E-02	c	6.5E-03	c	5.0E-02	1.8E-06	1.4E-05
				1.0E-02	H	4.0E-03	X	V		1		2.8E+03	Dibromomethane (Methylene Bromide)	74-95-3	2.5E+01	n	1.1E+02	n	4.2E+00	n	1.8E+01	n	7.9E+00	n		1.9E-03	
				1.0E-01	I					1	0.1		Dibutyl Phthalate	84-74-2	6.1E+03	n	6.2E+04	n					6.7E+02	n		1.7E+00	
				3.0E-04	P					1	0.1		Dibutyltin Compounds	NA	1.8E+01	n	1.8E+02	n					4.7E+00	n			
				3.0E-02	I					1	0.1		Dicamba	1918-00-9	1.8E+03	n	1.8E+04	n					4.4E+02	n		1.1E-01	
		4.2E-03	P					V		1		5.2E+02	Dichloro-2-butene, 1,4-	764-41-0	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
		4.2E-03	P					V		1	0.1	5.2E+02	Dichloro-2-butene, cis-1,4-	1476-11-5	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
		4.2E-03	P					V		1	0.1	7.6E+02	Dichloro-2-butene, trans-1,4-	110-57-6	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
5.0E-02	I			4.0E-03	I					1	0.1		Dichloroacetic Acid	79-43-6	9.7E+00	c*	3.4E+01	c*					1.3E+00	c*	6.0E+01	2.7E-04	1.2E-02
				9.0E-02	I	2.0E-01	H	V		1		3.8E+02	Dichlorobenzene, 1,2-	95-50-1	1.9E+03	ns	9.8E+03	ns	2.1E+02	n	8.8E+02	n	2.8E+02	n	6.0E+02	2.7E-01	5.8E-01
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		1			Dichlorobenzene, 1,4-	106-46-7	2.4E+00	c	1.2E+01	c	2.2E-01	c	1.1E+00	c	4.2E-01	c	7.5E+01	4.0E-04	7.2E-02
4.5E-01	I	3.4E-04	C							1	0.1		Dichlorobenzidine, 3,3'-	91-94-1	1.1E+00	c	3.8E+00	c	7.2E-03	c	3.6E-02	c	1.1E-01	c		7.1E-04	
				9.0E-03	X					1	0.1		Dichlorobenzophenone, 4,4'-	90-98-2	5.5E+02	n	5.5E+03	n					5.7E+01	n		3.5E-01	
				2.0E-01	I	1.0E-01	X	V		1		8.5E+02	Dichlorodifluoromethane	75-71-8	9.4E+01	n	4.0E+02	n	1.0E+02	n	4.4E+02	n	1.9E+02	n		3.0E-01	
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1		1.7E+03	Dichloroethane, 1,1-	75-34-3	3.3E+00	c	1.7E+01	c	1.5E+00	c	7.7E+00	c	2.4E+00	c		6.8E-04	
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		1		3.0E+03	Dichloroethane, 1,2-	107-06-2	4.3E-01	c*	2.2E+00	c*	9.4E-02	c*	4.7E-01	c*	1.5E-01	c*	5.0E+00	4.2E-05	1.4E-03
				5.0E-02	I	2.0E-01	I	V		1		1.2E+03	Dichloroethylene, 1,1-	75-35-4	2.4E+02	n	1.1E+03	n	2.1E+02	n	8.8E+02	n	2.6E+02	n	7.0E+00	9.3E-02	2.5E-03
				9.0E-03	H			V		1		1.3E+03	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	7.0E+02	n	9.2E+03	ns					1.3E+02	n		3.7E-02	
				2.0E-03	I			V		1		2.4E+03	Dichloroethylene, 1,2-cis-	156-59-2	1.6E+02	n	2.0E+03	n					2.8E+01	n	7.0E+01	8.2E-03	2.1E-02
				2.0E-02	I	6.0E-02	P	V		1		1.7E+03	Dichloroethylene, 1,2-trans-	156-60-5	1.5E+02	n	6.9E+02	n	6.3E+01	n	2.6E+02	n	8.6E+01	n	1.0E+02	2.5E-02	2.9E-02
				3.0E-03	I					1	0.1		Dichlorophenol, 2,4-	120-83-2	1.8E+02	n	1.8E+03	n					3.5E+01	n		4.1E-02	
				1.0E-02	I					1	0.05		Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	6.9E+02	n	7.7E+03	n					1.3E+02	n	7.0E+01	3.5E-02	1.8E-02
				8.0E-03	I					1	0.1		Dichlorophenoxybutyric Acid, 4-(2,4-	94-82-6	4.9E+02	n	4.9E+03	n					9.1E+01	n		3.6E-02	
3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		1		1.4E+03	Dichloropropane, 1,2-	78-87-5	9.4E-01	c*	4.7E+00	c*	2.4E-01	c*	1.2E+00	c*	3.8E-01	c*	5.0E+00	1.3E-04	1.7E-03
				2.0E-02	P			V		1		1.5E+03	Dichloropropane, 1,3-	142-28-9	1.6E+03	ns	2.0E+04	ns					2.9E+02	n		9.9E-02	
				3.0E-03	I					1	0.1		Dichloropropanol, 2,3-	616-23-9	1.8E+02	n	1.8E+03	n					4.6E+01	n		9.8E-03	
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1		1.6E+03	Dichloropropene, 1,3-	542-75-6	1.7E+00	c*	8.3E+00	c*	6.1E-01	c*	3.1E+00	c*	4.1E-01	c*		1.5E-04	
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1	0.1		Dichlorvos	62-73-7	1.7E+00	c*	5.9E+00	c*	2.9E-02	c*	1.5E-01	c*	2.3E-01	c*		7.0E-05	
				8.0E-03	P	7.0E-03	P	V		1			Dicyclopentadiene	77-73-6	3.1E+01	n	1.3E+02	n	3.1E+01	n	1.2E+01	n	1.2E+01	n		4.3E-02	
1.6E+01	I	4.6E-03	I	5.0E-05	I					1	0.1		Dieldrin	60-57-1	3.0E-02	c	1.1E-01	c	5.3E-04	c	2.7E-03	c	1.5E-03	c		6.1E-05	
		3.0E-04	C			5.0E-03	I			1	0.1		Diesel Engine Exhaust	NA					8.1E-03	c	4.1E-02	c					
				2.0E-03	P	2.0E-04	P			1	0.1		Diethanolamine	111-42-2	1.2E+02	n	1.2E+03	n	2.1E-01	n	8.8E-01	n	3.1E+01	n		6.3E-03	
				8.0E-01	I					1	0.1		Diethyl Phthalate	84-66-2	4.9E+04	n	4.9E+05	nm					1.1E+04	n		4.7E+00	
				3.0E-02	P	1.0E-04	P			1	0.1		Diethylene Glycol Monobutyl Ether	112-34-5	1.8E+03	n	1.8E+04	n	1.0E-01	n	4.4E-01	n	4.7E+02	n		1.0E-01	
				6.0E-02	P	3.0E-04	P			1	0.1		Diethylene Glycol Monoethyl Ether	111-90-0	3.6E+03	n	3.6E+04	n	3.1E-01	n	1.3E+00	n	9.4E+02	n		1.9E-01	
				1.0E-03	P					1	0.1		Diethylformamide	617-84-5	6.1E+01	n	6.2E+02	n					1.6E+01	n		3.2E-03	
3.5E+02	C	1.0E-01	C							1	0.1		Diethylstilbestrol	56-53-1	1.4E-03	c	4.9E-03	c	2.4E-05	c	1.2E-04	c	4.3E-05	c		2.4E-05	
				8.0E-02	I					1	0.1		Difenzoquat	43222-48-6	4.9E+03	n	4.9E+04	n					1.2E+03	n			
				2.0E-02	I					1	0.1		Diflubenzuron	35367-38-5	1.2E+03	n	1.2E+04	n					2.2E+02	n		2.5E-01	
						4.0E+01	I	V		1		1.4E+03	Difluoroethane, 1,1-	75-37-6	5.2E+04	ns	2.2E+05	nms	4.2E+04	n	1.8E+05	n	8.3E+04	n		2.8E+01	
4.4E-02	C	1.3E-05	C					V		1	0.1		Dihydrosafrole	94-58-6	2.4E-01	c	1.2E+00	c	1.9E-01	c	9.4E-01	c	2.6E-01	c		3.2E-04	
						7.0E-01	P	V		1		2.3E+03	Diisopropyl Ether	108-20-3	2.4E+03	ns	1.0E+04	ns	7.3E+02	n	3.1E+03	n	1.5E+03	n		3.7E-01	
				8.0E-02	I			V		1		5.3E+02	Diisopropyl Methylphosphonate	1445-75-6	6.3E+03	ns	8.2E+04	ns					1.2E+03	n		3.5E-01	
				2.0E-02	I					1	0.1		Dimethipin	55290-64-7	1.2E+03	n	1.2E+04	n					3.1E+02	n		6.9E-02	
				2.0E-04	I					1	0.1		Dimethoate	60-51-5	1.2E+01	n	1.2E+02	n					3.1E+00	n		7.0E-04	
1.4E-02	H									1	0.1		Dimethoxybenzidine, 3,3'-	119-90-4	3.5E+01	c	1.2E+02	c					4.7E+00	c		5.7E-03	
1.7E-03	P			6.0E-02	P					1	0.1		Dimethyl methylphosphonate	756-79-6	2.9E+02	c*	1.0E+03	c*					3.9E+01	c*		8.3E-03	
4.6E+00	C	1.3E-03	C							1	0.1		Dimethylamino azobenzene [p-]	60-11-7	1.1E-01	c	3.7E-01	c	1.9E-03	c	9.4E-03	c	4.3E-03	c		1.8E-05	
5.8E-01	H									1	0.1		Dimethylaniline HCl, 2,4-	21436-96-4	8.4E-01	c	3.0E+00	c					1.2E-01	c		1.0E-04	
2.0E-01	P			2.0E-03	X					1	0.1		Dimethylaniline, 2,4-	95-68-1	2.4E+00	c*	8.6E+00	c					3.2E-01	c*		1.8E-04	
				2.0E-03	I			V		1		8.3E+02	Dimethylaniline, N,N-	121-69-7	1.6E+02	n	2.0E+03	ns					2.7E+01	n		9.8E-03	
1.1E+01	P									1	0.1		Dimethylbenzidine, 3,3'-	119-93-7	4.4E-02	c	1.6E-01	c					5.6E-03	c		3.7E-05	
				1.0E-01	P	3.0E-02	I			1	0.1		Dimethylformamide	68-12-2	6.1E+03	n	6.2E+04	n	3.1E+01	n	1.3E+02	n	1.6E+03	n		3.2E-01	
				1.0E-04	X	2.0E-06	X			1	0.1		Dimethylhydrazine, 1,1-	57-14-7	6.1E+00	n	6.1E+01	n	2.1E-03	n	8.8E-03	n	1.6E+00	n		3.5E-04	
5.5E+02	C	1.6E-01	C							1	0.1		Dimethylhydrazine, 1,2-	540-73-8	8.8E-04	c	3.1E-03	c	1.5E-05	c	7.7E-05	c	1.2E-04	c		2.8E-08	

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Toxicity and Chemical-specific Information													Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vo c	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-02	I					1	0.1		Dimethylphenol, 2,4-	105-67-9	1.2E+03	n	1.2E+04	n					2.7E+02	n		3.2E-01	
				6.0E-04	I					1	0.1		Dimethylphenol, 2,6-	576-26-1	3.7E+01	n	3.7E+02	n					8.1E+00	n		9.8E-03	
				1.0E-03	I					1	0.1		Dimethylphenol, 3,4-	95-65-8	6.1E+01	n	6.2E+02	n					1.4E+01	n		1.6E-02	
				1.0E-01	I			V		1			Dimethylterephthalate	120-61-6	7.8E+03	n	1.0E+05	nm					1.4E+03	n		3.8E-01	
4.5E-02	C	1.3E-05	C					V		1	0.1	1.1E+03	Dimethylvinylchloride	513-37-1	2.0E-01	c	1.0E+00	c	1.9E-01	c	9.4E-01	c	2.8E-01	c		1.8E-04	
				8.0E-05	X					1	0.1		Dinitro-o-cresol, 4,6-	534-52-1	4.9E+00	n	4.9E+01	n					1.2E+00	n		2.0E-03	
				2.0E-03	I					1	0.1		Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	1.2E+02	n	1.2E+03	n					1.7E+01	n		5.7E-01	
				1.0E-04	P					1	0.1		Dinitrobenzene, 1,2-	528-29-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
				1.0E-04	I					1	0.1		Dinitrobenzene, 1,3-	99-65-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
				1.0E-04	P					1	0.1		Dinitrobenzene, 1,4-	100-25-4	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
				2.0E-03	I					1	0.1		Dinitrophenol, 2,4-	51-28-5	1.2E+02	n	1.2E+03	n					3.0E+01	n		3.4E-02	
6.8E-01	I									1	0.1		Dinitrotoluene Mixture, 2,4/2,6-	NA	7.2E-01	c	2.5E+00	c					9.2E-02	c		1.3E-04	
3.1E-01	C	8.9E-05	C	2.0E-03	I					1	0.102		Dinitrotoluene, 2,4-	121-14-2	1.6E+00	c*	5.5E+00	c	2.7E-02	c	1.4E-01	c	2.0E-01	c		2.8E-04	
1.5E+00	P			3.0E-04	X					1	0.099		Dinitrotoluene, 2,6-	606-20-2	3.3E-01	c*	1.2E+00	c					4.2E-02	c		5.8E-05	
				2.0E-03	S					1	0.006		Dinitrotoluene, 2-Amino-4,6-	35572-78-2	1.5E+02	n	2.0E+03	n					3.0E+01	n		2.3E-02	
				2.0E-03	S					1	0.009		Dinitrotoluene, 4-Amino-2,6-	19406-51-0	1.5E+02	n	1.9E+03	n					3.0E+01	n		2.3E-02	
4.5E-01	X			9.0E-04	X					1	0.1		Dinitrotoluene, Technical grade	25321-14-6	1.1E+00	c	3.8E+00	c					1.4E-01	c		1.9E-04	
				1.0E-03	I					1	0.1		Dinoseb	88-85-7	6.1E+01	n	6.2E+02	n					1.1E+01	n	7.0E+00	9.8E-02	6.2E-02
1.0E-01	I	7.7E-06	C	3.0E-02	I	1.1E-01	A			1	0.1		Dioxane, 1,4-	123-91-1	4.9E+00	c	1.7E+01	c	3.2E-01	c	1.6E+00	c	6.7E-01	c		1.4E-04	
													Dioxins															
6.2E+03	I	1.3E+00	I							1	0.03		~Hexachlorodibenzo-p-dioxin, Mixture	NA	9.4E-05	c	3.9E-04	c	1.9E-06	c	9.4E-06	c	1.1E-05	c		1.5E-05	
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C			1	0.03		~TCDD, 2,3,7,8-	1746-01-6	4.5E-06	c*	1.8E-05	c*	6.4E-08	c	3.2E-07	c	5.2E-07	c*	3.0E-05	2.6E-07	1.5E-05
				3.0E-02	I					1	0.1		Diphenamid	957-51-7	1.8E+03	n	1.8E+04	n					4.1E+02	n		4.0E+00	
				8.0E-04	X					1	0.1		Diphenyl Sulfone	127-63-9	4.9E+01	n	4.9E+02	n					1.1E+01	n		2.8E-02	
				2.5E-02	I					1	0.1		Diphenylamine	122-39-4	1.5E+03	n	1.5E+04	n					2.4E+02	n		4.4E-01	
8.0E-01	I	2.2E-04	I							1	0.1		Diphenylhydrazine, 1,2-	122-66-7	6.1E-01	c	2.2E+00	c	1.1E-02	c	5.6E-02	c	6.7E-02	c		2.2E-04	
				2.2E-03	I					1	0.1		Diquat	85-00-7	1.3E+02	n	1.4E+03	n					3.4E+01	n	2.0E+01	6.5E-01	3.7E-01
7.4E+00	C	2.1E-03	C							1	0.1		Direct Black 38	1937-37-7	6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		4.4E+00	
7.4E+00	C	2.1E-03	C							1	0.1		Direct Blue 6	2602-46-2	6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		1.4E+01	
6.7E+00	C	1.9E-03	C							1	0.1		Direct Brown 95	16071-86-6	7.3E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c			
				4.0E-05	I					1	0.1		Disulfoton	298-04-4	2.4E+00	n	2.5E+01	n					3.8E-01	n		7.1E-04	
				1.0E-02	I			V		1	0.1		Dithiane, 1,4-	505-29-3	6.1E+02	n	6.2E+03	n					1.5E+02	n		7.6E-02	
				2.0E-03	I					1	0.1		Diuron	330-54-1	1.2E+02	n	1.2E+03	n					2.8E+01	n		1.2E-02	
				4.0E-03	I					1	0.1		Dodine	2439-10-3	2.4E+02	n	2.5E+03	n					6.2E+01	n		3.2E-01	
				2.5E-02	I			V		1			EPTC	759-94-4	2.0E+03	n	2.6E+04	n					2.9E+02	n		1.5E-01	
				6.0E-03	I					1	0.1		Endosulfan	115-29-7	3.7E+02	n	3.7E+03	n					7.8E+01	n		1.1E+00	
				2.0E-02	I					1	0.1		Endothall	145-73-3	1.2E+03	n	1.2E+04	n					3.0E+02	n	1.0E+02	7.1E-02	2.4E-02
				3.0E-04	I					1	0.1		Endrin	72-20-8	1.8E+01	n	1.8E+02	n					1.7E+00	n	2.0E+00	6.8E-02	8.1E-02
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1		1.1E+04	Epichlorohydrin	106-89-8	2.0E+01	n	8.8E+01	n	1.0E+00	n	4.4E+00	n	2.0E+00	n		4.5E-04	
						2.0E-02	I	V		1		1.5E+04	Epoxybutane, 1,2-	106-88-7	1.7E+02	n	7.2E+02	n	2.1E+01	n	8.8E+01	n	4.2E+01	n		9.2E-03	
				5.0E-03	I					1	0.1		Ethephon	16672-87-0	3.1E+02	n	3.1E+03	n					7.8E+01	n		1.6E-02	
				5.0E-04	I					1	0.1		Ethion	563-12-2	3.1E+01	n	3.1E+02	n					3.2E+00	n		6.3E-03	
				1.0E-01	P	6.0E-02	P			1	0.1		Ethoxyethanol Acetate, 2-	111-15-9	6.1E+03	n	6.2E+04	n	6.3E+01	n	2.6E+02	n	1.5E+03	n		3.2E-01	
				4.0E-01	H	2.0E-01	I			1	0.1		Ethoxyethanol, 2-	110-80-5	2.4E+04	n	2.5E+05	nm	2.1E+02	n	8.8E+02	n	6.2E+03	n		1.3E+00	
				9.0E-01	I			V		1		1.1E+04	Ethyl Acetate	141-78-6	7.0E+04	ns	9.2E+05	nms					1.4E+04	n		2.9E+00	
4.8E-02	H							V		1		2.5E+03	Ethyl Acrylate	140-88-5	1.3E+01	c	6.0E+01	c					1.4E+00	c		3.0E-04	
						1.0E+01	I	V		1		2.1E+03	Ethyl Chloride	75-00-3	1.5E+04	ns	6.1E+04	ns	1.0E+04	n	4.4E+04	n	2.1E+04	n		5.9E+00	
				2.0E-01	I			V		1		1.0E+04	Ethyl Ether	60-29-7	1.6E+04	ns	2.0E+05	nms					3.1E+03	n		6.8E-01	
				9.0E-02	H	3.0E-01	P	V		1		1.1E+03	Ethyl Methacrylate	97-63-2	1.5E+03	ns	7.5E+03	ns	3.1E+02	n	1.3E+03	n	4.2E+02	n		9.9E-02	
				1.0E-05	I					1	0.1		Ethyl-p-nitrophenyl Phosphonate	2104-64-5	6.1E-01	n	6.2E+00	n					6.6E-02	n		2.1E-03	
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		1		4.8E+02	Ethylbenzene	100-41-4	5.4E+00	c	2.7E+01	c	9.7E-01	c	4.9E+00	c	1.3E+00	c	7.0E+02	1.5E-03	7.8E-01
				7.0E-02	P					1	0.1		Ethylene Cyanohydrin	109-78-4	4.3E+03	n	4.3E+04	n					1.1E+03	n		2.2E-01	
				9.0E-02	P					1	0.1		Ethylene Diamine	107-15-3	5.5E+03	n	5.5E+04	n					1.4E+03	n		3.2E-01	
				2.0E+00	I	4.0E-01	C			1	0.1		Ethylene Glycol	107-21-1	1.2E+05	nm	1.2E+06	nm	4.2E+02	n	1.8E+03	n	3.1E+04	n		6.3E+00	
				1.0E-01	I	1.6E+00	I			1	0.1		Ethylene Glycol Monobutyl Ether	111-76-2	6.1E+03	n	6.2E+04	n	1.7E+03	n	7.0E+03	n	1.5E+03	n		3.2E-01	
3.1E-01	C	8.8E-05	C			3.0E-02	C	V		1		1.2E+05	Ethylene Oxide	75-21-8	1.7E-01	c	8.3E-01	c	2.8E-02	c	1.4E-01	c	4.4E-02	c		9.1E-06	
4.5E-02	C	1.3E-05	C	8.0E-05	I					1	0.1		Ethylene Thiourea	96-45-7	4.9E+00	n	3.8E+01	c**	1.9E-01	c	9.4E-01	c	1.2E+00	n		2.8E-04	
6.5E+01	C	1.9E-02	C					V		1	0.1	1.5E+05	Ethyleneimine	151-56-4	2.3E-03	c	1.0E-02	c	1.3E-04	c	6.5E-04	c	2.1E-04	c		4.5E-08	
				3.0E+00	I					1	0.1		Ethylphthalyl Ethyl Glycolate	84-72-0	1.8E+05	nm	1.8E+06	nm					4.5E+04	n		1.0E+02	
				8.0E-03	I					1	0.1		Express	101200-48-0	4.9E+02	n	4.9E+03	n					1.2E+02	n		4.7E-02	
				2.5E-04	I					1	0.1		Fenamiphos	22224-92-6	1.5E+01	n	1.5E+02	n					3.4E+00	n		3.3E-03	
				2.5E-02	I					1	0.1		Fenpropathrin	39515-41-8	1.5E+03	n	1.5E+04	n					4.6E+01	n		2.1E+00	
				1.3E-02	I					1	0.1		Fluometuron	2164-17-2	7.9E+02	n	8.0E+03	n					1.9E+02	n		1.4E-01	
				4.0E-02	C	1.3E-02	C			1			Fluoride	16984-48-8	3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	6.2E+02	n		9.3E+01	
				6.0E-02	I	1.3E-02	C			1			Fluorine (Soluble Fluoride)	7782-41-4	4.7E+03	n	6.1E+04	n	1.4E+01	n	5.7E+01	n	9.3E+02	n	4.0E+03	1.4E+02	6.0E+02

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Toxicity and Chemical-specific Information													Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				8.0E-02	I					1	0.1		Fluridone	59756-60-4	4.9E+03	n	4.9E+04	n					1.1E+03	n		1.3E+02	
				2.0E-02	I					1	0.1		Flurprimidol	56425-91-3	1.2E+03	n	1.2E+04	n					2.6E+02	n		1.2E+00	
				6.0E-02	I					1	0.1		Flutolanil	66332-96-5	3.7E+03	n	3.7E+04	n					7.2E+02	n		3.9E+00	
				1.0E-02	I					1	0.1		Fluvalinate	69409-94-5	6.1E+02	n	6.2E+03	n					1.6E+02	n		2.3E+02	
3.5E-03	I			1.0E-01	I					1	0.1		Folpet	133-07-3	1.4E+02	c*	4.9E+02	c					1.7E+01	c*		4.1E-03	
1.9E-01	I									1	0.1		Fomesafen	72178-02-0	2.6E+00	c	9.1E+00	c					3.4E-01	c		1.1E-03	
				2.0E-03	I					1	0.1		Fonofos	944-22-9	1.2E+02	n	1.2E+03	n					1.8E+01	n		3.5E-02	
		1.3E-05	I	2.0E-01	I	9.8E-03	A			1	0.1		Formaldehyde	50-00-0	1.2E+04	n	1.2E+05	nm	1.9E-01	c*	9.4E-01	c*	3.1E+03	n		6.2E-01	
				9.0E-01	P	3.0E-04	X			1	0.1		Formic Acid	64-18-6	4.9E+04	n	4.2E+05	nm	3.1E-01	n	1.3E+00	n	1.4E+04	n		2.8E+00	
				3.0E+00	I					1	0.1		Fosetyl-AL	39148-24-8	1.8E+05	nm	1.8E+06	nm					4.7E+04	n			
													Furans															
				1.0E-03	X			V		1			~Dibenzofuran	132-64-9	7.8E+01	n	1.0E+03	n					5.8E+00	n		1.1E-01	
				1.0E-03	I			V		1		6.2E+03	~Furan	110-00-9	7.8E+01	n	1.0E+03	n					1.5E+01	n		5.7E-03	
				9.0E-01	I	2.0E+00	I	V		1	0.1	1.7E+05	~Tetrahydrofuran	109-99-9	1.8E+04	n	9.5E+04	n	2.1E+03	n	8.8E+03	n	3.2E+03	n		7.1E-01	
3.8E+00	H									1	0.1		Furazolidone	67-45-8	1.3E-01	c	4.5E-01	c					1.8E-02	c		3.4E-05	
				3.0E-03	I	5.0E-02	H			1	0.1		Furfural	98-01-1	1.8E+02	n	1.8E+03	n	5.2E+01	n	2.2E+02	n	4.6E+01	n		9.9E-03	
1.5E+00	C	4.3E-04	C							1	0.1		Furium	531-82-8	3.2E-01	c	1.1E+00	c	5.7E-03	c	2.9E-02	c	4.4E-02	c		5.9E-05	
3.0E-02	I	8.6E-06	C							1	0.1		Furmecyclox	60568-05-0	1.6E+01	c	5.7E+01	c	2.8E-01	c	1.4E+00	c	9.6E-01	c		1.0E-03	
				4.0E-04	I					1	0.1		Glufosinate, Ammonium	77182-82-2	2.4E+01	n	2.5E+02	n					6.3E+00	n		1.4E-03	
						8.0E-05	C			1	0.1		Glutaraldehyde	111-30-8	1.1E+05	nm	4.8E+05	nm	8.3E-02	n	3.5E-01	n					
				4.0E-04	I	1.0E-03	H			1	0.1		Glycidyl	765-34-4	2.4E+01	n	2.5E+02	n	1.0E+00	n	4.4E+00	n	6.2E+00	n		1.3E-03	
				1.0E-01	I					1	0.1		Glyphosate	1071-83-6	6.1E+03	n	6.2E+04	n					1.6E+03	n	7.0E+02	6.9E+00	3.1E+00
				3.0E-03	I					1	0.1		Goal	42874-03-3	1.8E+02	n	1.8E+03	n					2.4E+01	n		1.9E+00	
				3.0E-03	A	1.0E-02	A			1	0.1		Guthion	86-50-0	1.8E+02	n	1.8E+03	n	1.0E+01	n	4.4E+01	n	4.3E+01	n		1.3E-02	
				5.0E-05	I					1	0.1		Haloxyfop, Methyl	69806-40-2	3.1E+00	n	3.1E+01	n					5.8E-01	n		6.4E-03	
				1.3E-02	I					1	0.1		Harmony	79277-27-3	7.9E+02	n	8.0E+03	n					2.0E+02	n		6.1E-02	
4.5E+00	I	1.3E-03	I	5.0E-04	I					1	0.1		Heptachlor	76-44-8	1.1E-01	c	3.8E-01	c	1.9E-03	c	9.4E-03	c	1.8E-03	c	4.0E-01	1.4E-04	3.3E-02
9.1E+00	I	2.6E-03	I	1.3E-05	I					1	0.1		Heptachlor Epoxide	1024-57-3	5.3E-02	c*	1.9E-01	c*	9.4E-04	c	4.7E-03	c	3.3E-03	c*	2.0E-01	6.8E-05	4.1E-03
				2.0E-03	I					1	0.1		Hexabromobenzene	87-82-1	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.8E-01	
				2.0E-04	I					1	0.1		Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2	1.2E+01	n	1.2E+02	n					3.1E+00	n			
1.6E+00	I	4.6E-04	I	8.0E-04	I					1	0.1		Hexachlorobenzene	118-74-1	3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.2E-02	c	1.0E+00	5.3E-04	1.3E-02
7.8E-02	I	2.2E-05	I	1.0E-03	P					1	0.1		Hexachlorobutadiene	87-68-3	6.2E+00	c**	2.2E+01	c*	1.1E-01	c	5.6E-01	c	2.6E-01	c*		5.0E-04	
6.3E+00	I	1.8E-03	I	8.0E-03	A					1	0.1		Hexachlorocyclohexane, Alpha-	319-84-6	7.7E-02	c	2.7E-01	c	1.4E-03	c	6.8E-03	c	6.2E-03	c		3.6E-05	
1.8E+00	I	5.3E-04	I							1	0.1		Hexachlorocyclohexane, Beta-	319-85-7	2.7E-01	c	9.6E-01	c	4.6E-03	c	2.3E-02	c	2.2E-02	c		1.3E-04	
1.1E+00	C	3.1E-04	C	3.0E-04	I					1	0.04		Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	5.2E-01	c*	2.1E+00	c	7.8E-03	c	4.0E-02	c	3.6E-02	c*	2.0E-01	2.1E-04	1.2E-03
1.8E+00	I	5.1E-04	I							1	0.1		Hexachlorocyclohexane, Technical	608-73-1	2.7E-01	c	9.6E-01	c	4.8E-03	c	2.4E-02	c	2.2E-02	c		1.3E-04	
				6.0E-03	I	2.0E-04	I			1	0.1		Hexachlorocyclopentadiene	77-47-4	3.7E+02	n	3.7E+03	n	2.1E-01	n	8.8E-01	n	2.2E+01	n	5.0E+01	7.0E-02	1.6E-01
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I			1	0.1		Hexachloroethane	67-72-1	1.2E+01	c**	4.3E+01	c*	2.2E-01	c	1.1E+00	c	7.9E-01	c**		4.8E-04	
				3.0E-04	I					1	0.1		Hexachlorophene	70-30-4	1.8E+01	n	1.8E+02	n					4.7E+00	n		6.3E+00	
1.1E-01	I			3.0E-03	I					1	0.015		Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5.6E+00	c*	2.4E+01	c					6.1E-01	c*		2.3E-04	
						1.0E-05	I	V		1		5.2E+03	Hexamethylene Diisocyanate, 1,6-	822-06-0	3.4E+00	n	1.4E+01	n	1.0E-02	n	4.4E-02	n	2.1E-02	n		2.1E-04	
				4.0E-04	P					1	0.1		Hexamethylphosphoramide	680-31-9	2.4E+01	n	2.5E+02	n					6.2E+00	n		1.4E-03	
				6.0E-02	H	7.0E-01	I	V		1		1.4E+02	Hexane, N-	110-54-3	5.7E+02	ns	2.6E+03	ns	7.3E+02	n	3.1E+03	n	2.5E+02	n		1.8E+00	
				2.0E+00	P					1	0.1		Hexanedioic Acid	124-04-9	1.2E+05	nm	1.2E+06	nm					3.1E+04	n		7.7E+00	
				5.0E-03	I	3.0E-02	I	V		1		3.3E+03	Hexanone, 2-	591-78-6	2.1E+02	n	1.4E+03	n	3.1E+01	n	1.3E+02	n	3.4E+01	n		7.9E-03	
				3.3E-02	I					1	0.1		Hexazinone	51235-04-2	2.0E+03	n	2.0E+04	n					5.0E+02	n		2.3E-01	
3.0E+00	I	4.9E-03	I			3.0E-05	P			1			Hydrazine	302-01-2	2.1E-01	c	9.5E-01	c	5.0E-04	c*	2.5E-03	c*	2.2E-02	c			
3.0E+00	I	4.9E-03	I							1			Hydrazine Sulfate	10034-93-2	2.1E-01	c	9.5E-01	c	5.0E-04	c	2.5E-03	c	2.2E-02	c			
						2.0E-02	I			1			Hydrogen Chloride	7647-01-0	2.8E+07	nm	1.2E+08	nm	2.1E+01	n	8.8E+01	n					
				4.0E-02	C	1.4E-02	C			1			Hydrogen Fluoride	7664-39-3	3.1E+03	n	4.1E+04	n	1.5E+01	n	6.1E+01	n	6.2E+02	n			
						2.0E-03	I			1			Hydrogen Sulfide	7783-06-4	2.8E+06	nm	1.2E+07	nm	2.1E+00	n	8.8E+00	n					
6.0E-02	P			4.0E-02	P					1	0.1		Hydroquinone	123-31-9	8.1E+00	c	2.9E+01	c					1.1E+00	c		7.5E-04	
				1.3E-02	I					1	0.1		Imazalil	35554-44-0	7.9E+02	n	8.0E+03	n					1.4E+02	n		2.5E+00	
				2.5E-01	I					1	0.1		Imazaquin	81335-37-7	1.5E+04	n	1.5E+05	nm					3.8E+03	n		1.9E+01	
				1.0E-02	A					1			Iodine	7553-56-2	7.8E+02	n	1.0E+04	n					1.6E+02	n		9.4E+00	
				4.0E-02	I					1	0.1		Iprodione	36734-19-7	2.4E+03	n	2.5E+04	n					5.7E+02	n		1.7E-01	
				7.0E-01	P					1			Iron	7439-89-6	5.5E+04	n	7.2E+05	nm					1.1E+04	n		2.7E+02	
				3.0E-01	I					1	0.1		Isobutyl Alcohol	78-83-1	1.8E+04	n	1.8E+05	nm					4.6E+03	n		9.5E-01	
9.5E-04	I			2.0E-01	I	2.0E+00	C			1	0.1		Isophorone	78-59-1	5.1E+02	c*	1.8E+03	c*	2.1E+03	n	8.8E+03	n	6.7E+01	c*		2.2E-02	
				1.5E-02	I					1	0.1		Isopropalin	33820-53-0	9.2E+02	n	9.2E+03	n					2.9E+01	n		6.6E-01	
						7.0E+00	C			1	0.1		Isopropanol	67-63-0	9.9E+09	nm	4.2E+10	nm	7.3E+03	n	3.1E+04	n					
				1.0E-01	I					1	0.1		Isopropyl Methyl Phosphonic Acid	1832-54-8	6.1E+03	n	6.2E+04	n					1.6E+03	n		3.4E-01	
				5.0E-02	I					1	0.1		Isoxaben	82558-50-7	3.1E+03	n	3.1E+04	n					5.6E+02	n		1.5E+00	
						3.0E-01	A	V		1			JP-7	NA	4.3E+08	nm	1.8E+09	nm	3.1E+02	n	1.3E+03	n	6.3E+02	n			
				7.5E-02	I					1	0.1		Kerb	23950-58-5	4.6E+03	n	4.6E+04	n					9.0E+02	n		9.1E-01	

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Toxicity and Chemical-specific Information													Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-03	I					1	0.1		Lactofen	77501-63-4	1.2E+02	n	1.2E+03	n					1.9E+01	n		8.7E-01	
													Lead Compounds															
2.8E-01	C	8.0E-05	C							1	0.1		~Lead acetate	301-04-2	1.7E+00	c	6.2E+00	c	3.0E-02	c	1.5E-01	c	2.4E-01	c			
										1			~Lead and Compounds	7439-92-1	4.0E+02	L	8.0E+02	L	1.5E-01	L		L		L	1.5E+01		1.4E+01
3.8E-02	C	1.1E-05	C							1	0.1		~Lead subacetate	1335-32-6	1.3E+01	c	4.5E+01	c	2.2E-01	c	1.1E+00	c	1.8E+00	c			
				1.0E-07	I					1	0.1		~Tetraethyl Lead	78-00-2	6.1E-03	n	6.2E-02	n					9.9E-04	n		3.5E-06	
				2.0E-03	I					1	0.1		Linuron	330-55-2	1.2E+02	n	1.2E+03	n					2.6E+01	n		2.3E-02	
				2.0E-03	P					1			Lithium	7439-93-2	1.6E+02	n	2.0E+03	n					3.1E+01	n		9.3E+00	
				2.0E-01	I					1	0.1		Londax	83055-99-6	1.2E+04	n	1.2E+05	nm					3.1E+03	n		7.9E-01	
				5.0E-04	I					1	0.1		MCPA	94-74-6	3.1E+01	n	3.1E+02	n					5.7E+00	n		1.5E-03	
				1.0E-02	I					1	0.1		MCPB	94-81-5	6.1E+02	n	6.2E+03	n					1.1E+02	n		4.4E-02	
				1.0E-03	I					1	0.1		MCPP	93-65-2	6.1E+01	n	6.2E+02	n					1.2E+01	n		3.5E-03	
				2.0E-02	I					1	0.1		Malathion	121-75-5	1.2E+03	n	1.2E+04	n					3.0E+02	n		7.9E-02	
				1.0E-01	I	7.0E-04	C			1	0.1		Maleic Anhydride	108-31-6	6.1E+03	n	6.1E+04	n	7.3E-01	n	3.1E+00	n	1.5E+03	n		3.0E-01	
				5.0E-01	I					1	0.1		Maleic Hydrazide	123-33-1	3.1E+04	n	3.1E+05	nm					7.8E+03	n		1.6E+00	
				1.0E-04	P					1	0.1		Malononitrile	109-77-3	6.1E+00	n	6.2E+01	n					1.6E+00	n		3.2E-04	
				3.0E-02	H					1	0.1		Mancozeb	8018-01-7	1.8E+03	n	1.8E+04	n					4.6E+02	n		6.5E-01	
				5.0E-03	I					1	0.1		Maneb	12427-38-2	3.1E+02	n	3.1E+03	n					7.7E+01	n		1.1E-01	
				1.4E-01	I	5.0E-05	I			1			Manganese (Diet)	7439-96-5													
				2.4E-02	S	5.0E-05	I			0.04			Manganese (Non-diet)	7439-96-5	1.8E+03	n	2.3E+04	n	5.2E-02	n	2.2E-01	n	3.2E+02	n		2.1E+01	
				9.0E-05	H					1	0.1		Mephosfolan	950-10-7	5.5E+00	n	5.5E+01	n					1.4E+00	n		2.1E-03	
				3.0E-02	I					1	0.1		Mepiquat Chloride	24307-26-4	1.8E+03	n	1.8E+04	n					4.7E+02	n		1.6E-01	
													Mercury Compounds															
				3.0E-04	I	3.0E-04	S			0.07			~Mercuric Chloride (and other Mercury salts)	7487-94-7	2.3E+01	n	3.1E+02	n	3.1E-01	n	1.3E+00	n	4.3E+00	n	2.0E+00		
						3.0E-04	I	V		1		3.1E+00	~Mercury (elemental)	7439-97-6	1.0E+01	ns	4.3E+01	ns	3.1E-01	n	1.3E+00	n	6.3E-01	n	2.0E+00	3.3E-02	1.0E-01
				1.0E-04	I					1			~Methyl Mercury	22967-92-6	7.8E+00	n	1.0E+02	n					1.6E+00	n			
				8.0E-05	I					1	0.1		~Phenylmercuric Acetate	62-38-4	4.9E+00	n	4.9E+01	n					1.2E+00	n		3.9E-04	
				3.0E-05	I					1	0.1		Merphos	150-50-5	1.8E+00	n	1.8E+01	n					4.7E-01	n		4.6E-02	
				3.0E-05	I					1	0.1		Merphos Oxide	78-48-8	1.8E+00	n	1.8E+01	n					6.1E-02	n		3.0E-04	
				6.0E-02	I					1	0.1		Metalaxyl	57837-19-1	3.7E+03	n	3.7E+04	n					9.2E+02	n		2.5E-01	
				1.0E-04	I	3.0E-02	P	V		1		4.6E+03	Methacrylonitrile	126-98-7	7.6E+00	n	9.2E+01	n	3.1E+01	n	1.3E+02	n	1.5E+00	n		3.4E-04	
				5.0E-05	I					1	0.1		Methamidophos	10265-92-6	3.1E+00	n	3.1E+01	n					7.8E-01	n		1.6E-04	
				5.0E-01	I	4.0E+00	C			1	0.1		Methanol	67-56-1	3.1E+04	n	3.1E+05	nm	4.2E+03	n	1.8E+04	n	7.8E+03	n		1.6E+00	
				1.0E-03	I					1	0.1		Methidathion	950-37-8	6.1E+01	n	6.2E+02	n					1.5E+01	n		3.7E-03	
				2.5E-02	I					1	0.1		Methomyl	16752-77-5	1.5E+03	n	1.5E+04	n					3.9E+02	n		8.5E-02	
4.9E-02	C	1.4E-05	C							1	0.1		Methoxy-5-nitroaniline, 2-	99-59-2	9.9E+00	c	3.5E+01	c	1.7E-01	c	8.8E-01	c	1.3E+00	c		4.6E-04	
				5.0E-03	I					1	0.1		Methoxychlor	72-43-5	3.1E+02	n	3.1E+03	n					2.7E+01	n	4.0E+01	1.5E+00	2.2E+00
				8.0E-03	P	1.0E-03	P			1	0.1		Methoxyethanol Acetate, 2-	110-49-6	4.9E+02	n	4.9E+03	n	1.0E+00	n	4.4E+00	n	1.2E+02	n		2.6E-02	
				5.0E-03	P	2.0E-02	I			1	0.1		Methoxyethanol, 2-	109-86-4	3.1E+02	n	3.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n		1.6E-02	
				1.0E+00	X			V		1		2.9E+04	Methyl Acetate	79-20-9	7.8E+04	ns	1.0E+06	nms					1.6E+04	n		3.2E+00	
				3.0E-02	H	2.0E-02	P	V		1		6.8E+03	Methyl Acrylate	96-33-3	1.5E+02	n	6.4E+02	n	2.1E+01	n	8.8E+01	n	3.8E+01	n		8.1E-03	
				6.0E-01	I	5.0E+00	I	V		1		2.8E+04	Methyl Ethyl Ketone (2-Butanone)	78-93-3	2.8E+04	n	2.0E+05	nms	5.2E+03	n	2.2E+04	n	4.9E+03	n		1.0E+00	
		1.0E-03	X	1.0E-03	P	2.0E-05	X			1	0.1		Methyl Hydrazine	60-34-4	6.1E+01	n	6.1E+02	n	2.4E-03	c**	1.2E-02	c**	1.6E+01	n		3.5E-03	
				8.0E-02	H	3.0E+00	I	V		1		3.4E+03	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	5.3E+03	ns	5.3E+04	ns	3.1E+03	n	1.3E+04	n	1.0E+03	n		2.3E-01	
						1.0E-03	C	V		1	0.1	1.7E+04	Methyl Isocyanate	624-83-9	5.0E+00	n	2.1E+01	n	1.0E+00	n	4.4E+00	n	2.1E+00	n		5.9E-04	
				1.4E+00	I	7.0E-01	I	V		1		2.4E+03	Methyl Methacrylate	80-62-6	4.8E+03	ns	2.1E+04	ns	7.3E+02	n	3.1E+03	n	1.4E+03	n		3.0E-01	
				2.5E-04	I					1	0.1		Methyl Parathion	298-00-0	1.5E+01	n	1.5E+02	n					3.4E+00	n		5.7E-03	
				6.0E-02	X					1	0.1		Methyl Phosphonic Acid	993-13-5	3.7E+03	n	3.7E+04	n					9.4E+02	n		1.9E-01	
				6.0E-03	H	4.0E-02	H	V		1		3.9E+02	Methyl Styrene (Mixed Isomers)	25013-15-4	2.4E+02	n	1.5E+03	ns	4.2E+01	n	1.8E+02	n	3.2E+01	n		5.2E-02	
9.9E-02	C	2.8E-05	C							1	0.1		Methyl methanesulfonate	66-27-3	4.9E+00	c	1.7E+01	c	8.7E-02	c	4.4E-01	c	6.8E-01	c		1.4E-04	
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		1		8.9E+03	Methyl tert-Butyl Ether (MTBE)	1634-04-4	4.3E+01	c	2.2E+02	c	9.4E+00	c	4.7E+01	c	1.2E+01	c		2.8E-03	
				3.0E-04	X					1	0.1		Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2	1.8E+01	n	1.8E+02	n					4.7E+00	n		2.8E-03	
9.0E-03	P			2.0E-02	X					1	0.1		Methyl-5-Nitroaniline, 2-	99-55-8	5.4E+01	c*	1.9E+02	c*					7.0E+00	c*		3.9E-03	
8.3E+00	C	2.4E-03	C							1	0.1		Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	5.9E-02	c	2.1E-01	c	1.0E-03	c	5.1E-03	c	8.1E-03	c		2.8E-06	
1.3E-01	C	3.7E-05	C							1	0.1		Methylaniline Hydrochloride, 2-	636-21-5	3.7E+00	c	1.3E+01	c	6.6E-02	c	3.3E-01	c	5.0E-01	c		2.1E-04	
				1.0E-02	A					1	0.1		Methylarsonic acid	124-58-3	6.1E+02	n	6.2E+03	n					1.6E+02	n			
				2.0E-04	X					1	0.1		Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7	1.2E+01	n	1.2E+02	n					3.1E+00	n			
1.0E-01	X			3.0E-04	X					1	0.1		Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	4.9E+00	c**	1.7E+01	c*					6.7E-01	c**			
2.2E+01	C	6.3E-03	C						M	1	0.1		Methylcholanthrene, 3-	56-49-5	5.2E-03	c	7.8E-02	c	1.5E-04	c	1.9E-03	c	9.8E-04	c		1.9E-03	
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	1		3.3E+03	Methylene Chloride	75-09-2	5.6E+01	c**	9.6E+02	c**	9.6E+01	c**	1.2E+03	c**	9.9E+00	c**	5.0E+00	2.5E-03	1.3E-03
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	1	0.1		Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.2E+00	c	1.7E+01	c*	2.2E-03	c	2.9E-02	c	1.4E-01	c		1.6E-03	
4.6E-02	I	1.3E-05	C							1	0.1		Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.1E+01	c	3.7E+01	c	1.9E-01	c	9.4E-01	c	4.1E-01	c		2.3E-03	
1.6E+00	C	4.6E-04	C			2.0E-02	C			1	0.1		Methylenebisbenzenamine, 4,4'-	101-77-9	3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.1E-02	c		1.8E-04	
						6.0E-04	I				0.1		Methylenediphenyl Diisocyanate	101-68-8	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					
				7.0E-02	H			V		1		5.0E+02	Methylstyrene, Alpha-	98-83-9	5.5E+03	ns	7.2E+04	ns					5.8E+02	n		9.3E-01	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Screening Levels										Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.5E-01	I					1	0.1		Metolachlor	51218-45-2	9.2E+03	n	9.2E+04	n					2.1E+03	n		2.5E+00	
				2.5E-02	I					1	0.1		Metribuzin	21087-64-9	1.5E+03	n	1.5E+04	n					3.8E+02	n		1.2E-01	
				3.0E+00	P			V		1	0.1	3.4E-01	Mineral oils	8012-95-1	1.8E+05	nms	1.8E+06	nms					4.7E+04	n		1.9E+03	
1.8E+01	C	5.1E-03	C	2.0E-04	I					1	0.1		Mirex	2385-85-5	2.7E-02	c	9.6E-02	c	4.8E-04	c	2.4E-03	c	3.7E-03	c		2.7E-03	
				2.0E-03	I					1	0.1		Molinate	2212-67-1	1.2E+02	n	1.2E+03	n					2.3E+01	n		1.3E-02	
				5.0E-03	I					1			Molybdenum	7439-98-7	3.9E+02	n	5.1E+03	n					7.8E+01	n		1.6E+00	
				1.0E-01	I					1			Monochloramine	10599-90-3	7.8E+03	n	1.0E+05	nm					1.6E+03	n	4.0E+03		
				2.0E-03	P					1	0.1		Monomethylaniline	100-61-8	1.2E+02	n	1.2E+03	n					3.0E+01	n		1.1E-02	
				3.0E-04	X					1	0.1		N,N'-Diphenyl-1,4-benzenediamine	74-31-7	1.8E+01	n	1.8E+02	n					2.7E+00	n		2.8E-01	
				2.0E-03	I					1	0.1		Naled	300-76-5	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.4E-02	
				3.0E-02	X	1.0E-01	P	V		1			Naphtha, High Flash Aromatic (HFAN)	64724-95-6	2.3E+03	n	3.1E+04	n	1.0E+02	n	4.4E+02	n	1.4E+02	n			
1.8E+00	C	0.0E+00	C							1	0.1		Naphthylamine, 2-	91-59-8	2.7E-01	c	9.6E-01	c					3.3E-02	c		1.7E-04	
				1.0E-01	I					1	0.1		Napropamide	15299-99-7	6.1E+03	n	6.2E+04	n					1.3E+03	n		8.3E+00	
				1.1E-02	C	1.4E-05	C			0.04			Nickel Carbonyl	13463-39-3	8.2E+02	n	9.9E+03	n	1.5E-02	n	6.1E-02	n	1.5E+02	n			
				1.1E-02	C	2.0E-05	C			1			Nickel Oxide	1313-99-1	8.4E+02	n	1.0E+04	n	2.1E-02	n	8.8E-02	n	1.7E+02	n			
		2.4E-04	I	1.1E-02	C	1.4E-05	C			0.04			Nickel Refinery Dust	NA	8.2E+02	n	9.9E+03	n	1.0E-02	c**	5.1E-02	c**	1.7E+02	n		2.5E+01	
		2.6E-04	C	2.0E-02	I	9.0E-05	A			0.04			Nickel Soluble Salts	7440-02-0	1.5E+03	n	2.0E+04	n	9.4E-03	c*	4.7E-02	c**	3.0E+02	n		2.0E+01	
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C			0.04			Nickel Subsulfide	12035-72-2	3.8E-01	c	1.7E+00	c	5.1E-03	c**	2.6E-02	c**	3.9E-02	c			
				1.6E+00	I					1			Nitrate	14797-55-8	1.3E+05	nm	1.6E+06	nm					2.5E+04	n	1.0E+04		
										1			Nitrate + Nitrite (as N)	NA											1.0E+04		
				1.0E-01	I					1			Nitrite	14797-65-0	7.8E+03	n	1.0E+05	nm					1.6E+03	n	1.0E+03		
				1.0E-02	X	5.0E-05	X			1	0.1		Nitroaniline, 2-	88-74-4	6.1E+02	n	6.0E+03	n	5.2E-02	n	2.2E-01	n	1.5E+02	n		6.2E-02	
2.0E-02	P			4.0E-03	P	6.0E-03	P			1	0.1		Nitroaniline, 4-	100-01-6	2.4E+01	c*	8.6E+01	c*	6.3E+00	n	2.6E+01	n	3.3E+00	c*		1.4E-03	
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		1		3.1E+03	Nitrobenzene	98-95-3	4.8E+00	c*	2.4E+01	c*	6.1E-02	c	3.1E-01	c	1.2E-01	c*		7.9E-05	
				3.0E+03	P					1	0.1		Nitrocellulose	9004-70-0	1.8E+08	nm	1.8E+09	nm					4.7E+07	n		1.0E+04	
				7.0E-02	H					1	0.1		Nitrofurantoin	67-20-9	4.3E+03	n	4.3E+04	n					1.1E+03	n		4.7E-01	
1.3E+00	C	3.7E-04	C							1	0.1		Nitrofurazone	59-87-0	3.7E-01	c	1.3E+00	c	6.6E-03	c	3.3E-02	c	5.2E-02	c		4.6E-05	
1.7E-02	P			1.0E-04	P					1	0.1		Nitroglycerin	55-63-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		6.6E-04	
				1.0E-01	I					1	0.1		Nitroguanidine	556-88-7	6.1E+03	n	6.2E+04	n					1.6E+03	n		3.8E-01	
		9.0E-06	P			2.0E-02	P	V		1		1.8E+04	Nitromethane	75-52-5	4.9E+00	c*	2.5E+01	c*	2.7E-01	c*	1.4E+00	c*	5.4E-01	c*		1.2E-04	
		2.7E-03	H			2.0E-02	I	V		1		4.9E+03	Nitropropane, 2-	79-46-9	1.3E-02	c	6.4E-02	c	9.0E-04	c	4.5E-03	c	1.8E-03	c		4.7E-07	
2.7E+01	C	7.7E-03	C						M	1	0.1		Nitroso-N-ethylurea, N-	759-73-9	4.3E-03	c	6.4E-02	c	1.2E-04	c	1.6E-03	c	7.9E-04	c		1.9E-07	
1.2E+02	C	3.4E-02	C						M	1	0.1		Nitroso-N-methylurea, N-	684-93-5	9.6E-04	c	1.4E-02	c	2.8E-05	c	3.6E-04	c	1.8E-04	c		4.0E-08	
5.4E+00	I	1.6E-03	I					V		1			Nitroso-di-N-butylamine, N-	924-16-3	8.7E-02	c	4.0E-01	c	1.5E-03	c	7.7E-03	c	2.4E-03	c		4.8E-06	
7.0E+00	I	2.0E-03	C							1	0.1		Nitroso-di-N-propylamine, N-	621-64-7	6.9E-02	c	2.5E-01	c	1.2E-03	c	6.1E-03	c	9.3E-03	c		7.0E-06	
2.8E+00	I	8.0E-04	C							1	0.1		Nitrosodiethanolamine, N-	1116-54-7	1.7E-01	c	6.2E-01	c	3.0E-03	c	1.5E-02	c	2.4E-02	c		4.8E-06	
1.5E+02	I	4.3E-02	I						M	1	0.1		Nitrosodiethylamine, N-	55-18-5	7.7E-04	c	1.1E-02	c	2.2E-05	c	2.9E-04	c	1.4E-04	c		5.2E-08	
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	1	0.1		Nitrosodimethylamine, N-	62-75-9	2.3E-03	c	3.4E-02	c	6.9E-05	c	8.8E-04	c	4.2E-04	c		1.0E-07	
4.9E-03	I	2.6E-06	C							1	0.1		Nitrosodiphenylamine, N-	86-30-6	9.9E+01	c	3.5E+02	c	9.4E-01	c	4.7E+00	c	1.0E+01	c		5.7E-02	
2.2E+01	I	6.3E-03	C							1	0.1		Nitrosomethylethylamine, N-	10595-95-6	2.2E-02	c	7.8E-02	c	3.9E-04	c	1.9E-03	c	3.0E-03	c		8.7E-07	
6.7E+00	C	1.9E-03	C							1	0.1		Nitrosomorpholine [N-]	59-89-2	7.3E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c		2.5E-06	
9.4E+00	C	2.7E-03	C							1	0.1		Nitrosopiperidine [N-]	100-75-4	5.2E-02	c	1.8E-01	c	9.0E-04	c	4.5E-03	c	7.1E-03	c		3.8E-06	
2.1E+00	I	6.1E-04	I							1	0.1		Nitrosopyrrolidine, N-	930-55-2	2.3E-01	c	8.2E-01	c	4.0E-03	c	2.0E-02	c	3.2E-02	c		1.2E-05	
				1.0E-04	X					1	0.1		Nitrotoluene, m-	99-08-1	6.1E+00	n	6.2E+01	n					1.3E+00	n		1.2E-03	
2.2E-01	P			9.0E-04	P			V		1		1.5E+03	Nitrotoluene, o-	88-72-2	2.9E+00	c*	1.3E+01	c*					2.7E-01	c*		2.5E-04	
1.6E-02	P			4.0E-03	P					1	0.1		Nitrotoluene, p-	99-99-0	3.0E+01	c**	1.1E+02	c*					3.7E+00	c*		3.4E-03	
				3.0E-04	X	2.0E-01	P	V		1		6.9E+00	Nonane, n-	111-84-2	2.1E+01	ns	2.3E+02	ns	2.1E+02	n	8.8E+02	n	4.6E+00	n		6.6E-02	
				4.0E-02	I					1	0.1		Norflurazon	27314-13-2	2.4E+03	n	2.5E+04	n					6.0E+02	n		3.9E+00	
				7.0E-04	I					1	0.1		Nustar	85509-19-9	4.3E+01	n	4.3E+02	n					8.3E+00	n		1.4E+00	
				3.0E-03	I					1	0.1		Octabromodiphenyl Ether	32536-52-0	1.8E+02	n	1.8E+03	n					4.7E+01	n		9.3E+00	
				5.0E-02	I					1	0.006		Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0	3.8E+03	n	4.9E+04	n					7.8E+02	n		9.9E-01	
				2.0E-03	H					1	0.1		Octamethylpyrophosphoramide	152-16-9	1.2E+02	n	1.2E+03	n					3.1E+01	n		7.5E-03	
				1.0E-02	P					1	0.1		Octyl Phthalate, di-N-	117-84-0	6.1E+02	n	6.2E+03	n					1.6E+02	n		4.4E+01	
				5.0E-02	I					1	0.1		Oryzalin	19044-88-3	3.1E+03	n	3.1E+04	n					6.2E+02	n		1.1E+00	
				5.0E-03	I					1	0.1		Oxadiazon	19666-30-9	3.1E+02	n	3.1E+03	n					3.5E+01	n		3.6E-01	
				2.5E-02	I					1	0.1		Oxamyl	23135-22-0	1.5E+03	n	1.5E+04	n					3.9E+02	n	2.0E+02	8.6E-02	4.4E-02
				1.3E-02	I					1	0.1		Paclobutrazol	76738-62-0	7.9E+02	n	8.0E+03	n					1.7E+02	n		3.6E-01	
				4.5E-03	I					1	0.1		Paraquat Dichloride	1910-42-5	2.7E+02	n	2.8E+03	n					7.0E+01	n		9.7E-01	
				6.0E-03	H					1	0.1		Parathion	56-38-2	3.7E+02	n	3.7E+03	n					6.5E+01	n		3.3E-01	
				5.0E-02	H					1	0.1		Pebulate	1114-71-2	3.1E+03	n	3.1E+04	n					4.2E+02	n		3.3E-01	
				4.0E-02	I					1	0.1		Pendimethalin	40487-42-1	2.4E+03	n	2.5E+04	n					1.3E+02	n		1.5E+00	
				2.0E-03	I					1	0.1		Pentabromodiphenyl Ether	32534-81-9	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.4E+00	
				1.0E-04	I					1	0.1		Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	6.1E+00	n	6.2E+01	n					1.6E+00	n		6.8E-02	
				8.0E-04	I					1	0.1		Pentachlorobenzene	608-93-5	4.9E+01	n	4.9E+02	n					2.3E+00	n		1.7E-02	
9.0E-02	P									1	0.1		Pentachloroethane	76-01-7	5.4E+00	c	1.9E+01	c					5.6E-01	c		2.7E-04	

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Toxicity and Chemical-specific Information												Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
2.6E-01	H			3.0E-03	I					1	0.1		Pentachloronitrobenzene	82-68-8	1.9E+00	c*	6.6E+00	c					1.0E-01	c		1.3E-03	
4.0E-01	I	5.1E-06	C	5.0E-03	I					1	0.25		Pentachlorophenol	87-86-5	8.9E-01	c	2.7E+00	c	4.8E-01	c	2.4E+00	c	3.5E-02	c	1.0E+00	3.6E-04	1.0E-02
4.0E-03	X			2.0E-03	P					1	0.1		Pentaerythritol tetranitrate (PETN)	78-11-5	1.2E+02	c**	4.3E+02	c**					1.6E+01	c**		2.4E-02	
						1.0E+00	P	V		1		3.9E+02	Pentane, n-	109-66-0	8.7E+02	ns	3.7E+03	ns	1.0E+03	n	4.4E+03	n	2.1E+03	n		1.0E+01	
													Perchlorates															
				7.0E-04	I					1			~Ammonium Perchlorate	7790-98-9	5.5E+01	n	7.2E+02	n					1.1E+01	n			
				7.0E-04	I					1			~Lithium Perchlorate	7791-03-9	5.5E+01	n	7.2E+02	n					1.1E+01	n			
				7.0E-04	I					1			~Perchlorate and Perchlorate Salts	14797-73-0	5.5E+01	n	7.2E+02	n					1.1E+01	n	1.5E+01(F)		
				7.0E-04	I					1			~Potassium Perchlorate	7778-74-7	5.5E+01	n	7.2E+02	n					1.1E+01	n			
				7.0E-04	I					1			~Sodium Perchlorate	7601-89-0	5.5E+01	n	7.2E+02	n					1.1E+01	n			
				5.0E-02	I					1	0.1		Permethrin	52645-53-1	3.1E+03	n	3.1E+04	n					7.8E+02	n		1.9E+02	
2.2E-03	C	6.3E-07	C							1	0.1		Phenacetin	62-44-2	2.2E+02	c	7.8E+02	c	3.9E+00	c	1.9E+01	c	3.0E+01	c		8.3E-03	
				2.5E-01	I					1	0.1		Phenmedipham	13684-63-4	1.5E+04	n	1.5E+05	nm					3.0E+03	n		1.6E+01	
				3.0E-01	I	2.0E-01	C			1	0.1		Phenol	108-95-2	1.8E+04	n	1.8E+05	nm	2.1E+02	n	8.8E+02	n	4.5E+03	n		2.6E+00	
				5.0E-04	X					1	0.1		Phenothiazine	92-84-2	3.1E+01	n	3.1E+02	n					3.2E+00	n		1.0E-02	
				6.0E-03	I					1	0.1		Phenylenediamine, m-	108-45-2	3.7E+02	n	3.7E+03	n					9.4E+01	n		2.5E-02	
4.7E-02	H									1	0.1		Phenylenediamine, o-	95-54-5	1.0E+01	c	3.7E+01	c					1.4E+00	c		3.8E-04	
				1.9E-01	H					1	0.1		Phenylenediamine, p-	106-50-3	1.2E+04	n	1.2E+05	nm					3.0E+03	n		7.9E-01	
1.9E-03	H									1	0.1		Phenylphenol, 2-	90-43-7	2.5E+02	c	8.9E+02	c					2.6E+01	c		3.5E-01	
				2.0E-04	H					1	0.1		Phorate	298-02-2	1.2E+01	n	1.2E+02	n					2.3E+00	n		2.6E-03	
						3.0E-04	I	V		1		1.6E+03	Phosgene	75-44-5	3.3E-01	n	1.4E+00	n	3.1E-01	n	1.3E+00	n					
				2.0E-02	I					1	0.1		Phosmet	732-11-6	1.2E+03	n	1.2E+04	n					2.9E+02	n		6.4E-02	
													Phosphates, Inorganic															
				4.9E+01	P					1			~Aluminum metaphosphate	13776-88-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Ammonium polyphosphate	68333-79-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Calcium pyrophosphate	7790-76-3	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Diammonium phosphate	7783-28-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Dicalcium phosphate	7757-93-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Dimagnesium phosphate	7782-75-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Dipotassium phosphate	7758-11-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Disodium phosphate	7558-79-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monoaluminum phosphate	13530-50-2	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monoammonium phosphate	7722-76-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monocalcium phosphate	7758-23-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monomagnesium phosphate	7757-86-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monopotassium phosphate	7778-77-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Monosodium phosphate	7558-80-7	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Polyphosphoric acid	8017-16-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Potassium tripolyphosphate	13845-36-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium acid pyrophosphate	7758-16-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium aluminum phosphate (acidic)	7785-88-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium aluminum phosphate (anhydrous)	10279-59-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium aluminum phosphate (tetrahydrate)	10305-76-7	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium hexametaphosphate	10124-56-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium polyphosphate	68915-31-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium trimetaphosphate	7785-84-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Sodium tripolyphosphate	7758-29-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Tetrapotassium phosphate	7320-34-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Tetrasodium pyrophosphate	7722-88-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Tricalcium phosphate	7758-87-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Trimagnesium phosphate	7757-87-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Tripotassium phosphate	7778-53-2	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				4.9E+01	P					1			~Trisodium phosphate	7601-54-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
				3.0E-04	I	3.0E-04	I			1			Phosphine	7803-51-2	2.3E+01	n	3.1E+02	n	3.1E-01	n	1.3E+00	n	4.7E+00	n			
				4.9E+01	P	1.0E-02	I			1			Phosphoric Acid	7664-38-2	3.0E+06	nm	2.7E+07	nm	1.0E+01	n	4.4E+01	n	7.6E+05	n			
				2.0E-05	I					1			Phosphorus, White	7723-14-0	1.6E+00	n	2.0E+01	n					3.1E-01	n		1.1E-03	
				1.0E+00	H					1	0.1		Phthalic Acid, P-	100-21-0	6.1E+04	n	6.2E+05	nm					1.5E+04	n		5.3E+00	
				2.0E+00	I	2.0E-02	C			1	0.1		Phthalic Anhydride	85-44-9	1.2E+05	nm	1.2E+06	nm	2.1E+01	n	8.8E+01	n	3.0E+04	n		6.6E+00	
				7.0E-02	I					1	0.1		Picloram	1918-02-1	4.3E+03	n	4.3E+04	n					1.1E+03	n	5.0E+02	2.9E-01	1.4E-01
				1.0E-04	X					1	0.1		Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.0E-03	
				1.0E-02	I					1	0.1		Pirimiphos, Methyl	29232-93-7	6.1E+02	n	6.2E+03	n					9.1E+01	n		8.7E-02	
3.0E+01	C	8.6E-03	C	7.0E-06	H					1	0.1		Polybrominated Biphenyls	59536-65-1	1.6E-02	c*	5.7E-02	c*	2.8E-04	c	1.4E-03	c	2.2E-03	c*			
													Polychlorinated Biphenyls (PCBs)															
7.0E-02	S	2.0E-05	S	7.0E-05	I					1	0.14		~Aroclor 1016	12674-11-2	3.9E+00	n	2.1E+01	c**	1.2E-01	c	6.1E-01	c	9.6E-01	c**		9.2E-02	

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Toxicity and Chemical-specific Information												Contaminant		Screening Levels											Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
2.0E+00	S	5.7E-04	S					V		1	0.14	7.6E+02	~Aroclor 1221	11104-28-2	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	4.0E-03	c		6.9E-05	
2.0E+00	S	5.7E-04	S					V		1	0.14	7.3E+01	~Aroclor 1232	11141-16-5	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	4.0E-03	c		6.9E-05	
2.0E+00	S	5.7E-04	S							1	0.14		~Aroclor 1242	53469-21-9	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.3E-03	
2.0E+00	S	5.7E-04	S							1	0.14		~Aroclor 1248	12672-29-6	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.2E-03	
2.0E+00	S	5.7E-04	S	2.0E-05	I					1	0.14		~Aroclor 1254	11097-69-1	2.2E-01	c**	7.4E-01	c*	4.3E-03	c	2.1E-02	c	3.4E-02	c**		8.8E-03	
2.0E+00	S	5.7E-04	S							1	0.14		~Aroclor 1260	11096-82-5	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		2.4E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		1.2E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.2E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.4E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.4E-03	
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E			1	0.14		~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.1E-04	c*	3.8E-04	c*	2.1E-06	c	1.1E-05	c	1.7E-05	c*		7.2E-06	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 118)	31508-00-6	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.4E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E			1	0.14		~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	3.4E-05	c*	1.1E-04	c*	6.4E-07	c	3.2E-06	c	5.2E-06	c*		1.3E-06	
2.0E+00	I	5.7E-04	I							1	0.14		~Polychlorinated Biphenyls (high risk)	1336-36-3	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c					
4.0E-01	I	1.0E-04	I							1	0.14		~Polychlorinated Biphenyls (low risk)	1336-36-3					2.4E-02	c	1.2E-01	c	1.7E-01	c	5.0E-01	2.6E-02	7.8E-02
7.0E-02	I	2.0E-05	I							1	0.14		~Polychlorinated Biphenyls (lowest risk)	1336-36-3					1.2E-01	c	6.1E-01	c					
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			1	0.14		~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	3.4E-02	c*	1.1E-01	c*	6.4E-04	c	3.2E-03	c	5.2E-03	c*		8.1E-04	
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E			1	0.14		~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.1E-02	c*	3.8E-02	c*	2.1E-04	c	1.1E-03	c	1.7E-03	c*		2.7E-04	
						6.0E-04	I			1	0.1		Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					
													Polynuclear Aromatic Hydrocarbons (PAHs)													
				6.0E-02	I			V		1	0.13		~Acenaphthene	83-32-9	3.4E+03	n	3.3E+04	n					4.0E+02	n		4.1E+00	
				3.0E-01	I			V		1	0.13		~Anthracene	120-12-7	1.7E+04	n	1.7E+05	nm					1.3E+03	n		4.2E+01	
7.3E-01	E	1.1E-04	C						M	1	0.13		~Benz[a]anthracene	56-55-3	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		1.0E-02	
1.2E+00	C	1.1E-04	C							1	0.13		~Benzo(j)fluoranthene	205-82-3	3.8E-01	c	1.3E+00	c	2.2E-02	c	1.1E-01	c	5.6E-02	c		6.7E-02	
7.3E+00	I	1.1E-03	C						M	1	0.13		~Benzo[a]pyrene	50-32-8	1.5E-02	c	2.1E-01	c	8.7E-04	c	1.1E-02	c	2.9E-03	c	2.0E-01	3.5E-03	2.4E-01
7.3E-01	E	1.1E-04	C						M	1	0.13		~Benzo[b]fluoranthene	205-99-2	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		3.5E-02	
7.3E-02	E	1.1E-04	C						M	1	0.13		~Benzo[k]fluoranthene	207-08-9	1.5E+00	c	2.1E+01	c	8.7E-03	c	1.1E-01	c	2.9E-01	c		3.5E-01	
7.3E-03	E	1.1E-05	C						M	1	0.13		~Chrysene	218-01-9	1.5E+01	c	2.1E+02	c	8.7E-02	c	1.1E+00	c	2.9E+00	c		1.1E+00	
7.3E+00	E	1.2E-03	C						M	1	0.13		~Dibenz[a,h]anthracene	53-70-3	1.5E-02	c	2.1E-01	c	8.0E-04	c	1.0E-02	c	2.9E-03	c		1.1E-02	
1.2E+01	C	1.1E-03	C							1	0.13		~Dibenzo(a,e)pyrene	192-65-4	3.8E-02	c	1.3E-01	c	2.2E-03	c	1.1E-02	c	5.6E-03	c		7.3E-02	
2.5E+02	C	7.1E-02	C						M	1	0.13		~Dimethylbenz(a)anthracene, 7,12-	57-97-6	4.3E-04	c	6.2E-03	c	1.4E-05	c	1.7E-04	c	8.6E-05	c		8.5E-05	
				4.0E-02	I					1	0.13		~Fluoranthene	206-44-0	2.3E+03	n	2.2E+04	n					6.3E+02	n		7.0E+01	
				4.0E-02	I			V		1	0.13		~Fluorene	86-73-7	2.3E+03	n	2.2E+04	n					2.2E+02	n		4.0E+00	
7.3E-01	E	1.1E-04	C						M	1	0.13		~Indeno[1,2,3-cd]pyrene	193-39-5	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		2.0E-01	
2.9E-02	P			7.0E-02	A			V		1	0.13		~Methylnaphthalene, 1-	90-12-0	1.6E+01	c	5.3E+01	c					9.7E-01	c		5.1E-03	
				4.0E-03	I			V		1	0.13		~Methylnaphthalene, 2-	91-57-6	2.3E+02	n	2.2E+03	n					2.7E+01	n		1.4E-01	
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		1	0.13		~Naphthalene	91-20-3	3.6E+00	c*	1.8E+01	c*	7.2E-02	c*	3.6E-01	c*	1.4E-01	c*		4.7E-04	
1.2E+00	C	1.1E-04	C							1	0.13		~Nitropyrene, 4-	57835-92-4	3.8E-01	c	1.3E+00	c	2.2E-02	c	1.1E-01	c	1.6E-02	c		2.8E-03	
				3.0E-02	I			V		1	0.13		~Pyrene	129-00-0	1.7E+03	n	1.7E+04	n					8.7E+01	n		9.5E+00	
1.5E-01	I			9.0E-03	I					1	0.1		Prochloraz	67747-09-5	3.2E+00	c	1.1E+01	c					3.2E-01	c		1.6E-03	
				6.0E-03	H					1	0.1		Profluralin	26399-36-0	3.7E+02	n	3.7E+03	n					1.9E+01	n		1.2E+00	
				1.5E-02	I					1	0.1		Prometon	1610-18-0	9.2E+02	n	9.2E+03	n					1.9E+02	n		9.2E-02	
				4.0E-03	I					1	0.1		Prometryn	7287-19-6	2.4E+02	n	2.5E+03	n					4.5E+01	n		6.9E-02	
				1.3E-02	I					1	0.1		Propachlor	1918-16-7	7.9E+02	n	8.0E+03	n					1.9E+02	n		1.2E-01	
				5.0E-03	I					1	0.1		Propanil	709-98-8	3.1E+02	n	3.1E+03	n					6.3E+01	n		3.5E-02	
				2.0E-02	I					1	0.1		Propargite	2312-35-8	1.2E+03	n	1.2E+04	n					1.2E+02	n		8.8E+00	
				2.0E-03	I					1	0.1		Propargyl Alcohol	107-19-7	1.2E+02	n	1.2E+03	n					3.1E+01	n		6.4E-03	
				2.0E-02	I					1	0.1		Propazine	139-40-2	1.2E+03	n	1.2E+04	n					2.6E+02	n		2.3E-01	
				2.0E-02	I					1	0.1		Propham	122-42-9	1.2E+03	n	1.2E+04	n					2.7E+02	n		1.7E-01	
				1.3E-02	I					1	0.1		Propiconazole	60207-90-1	7.9E+02	n	8.0E+03	n					1.6E+02	n		5.3E-01	
						8.0E-03	I	V		1		3.3E+04	Propionaldehyde	123-38-6	8.0E+01	n	3.4E+02	n	8.3E+00	n	3.5E+01	n	1.7E+01	n		3.4E-03	
				1.0E-01	X	1.0E+00	X	V		1	0.1	2.6E+02	Propyl benzene	103-65-1	3.4E+03	ns	2.1E+04	ns	1.0E+03	n	4.4E+03	n	5.3E+02	n		9.9E-01	
						3.0E+00	C	V		1	0.1	3.5E+02	Propylene	115-07-1	2.4E+03	ns	1.0E+04	ns	3.1E+03	n	1.3E+04	n	6.3E+03	n		6.0E+00	
				2.0E+01	P					1	0.1		Propylene Glycol	57-55-6	1.2E+06	nm	1.2E+07	nm					3.1E+05	n		6.3E+01	
						2.7E-04	A			1	0.1		Propylene Glycol Dinitrate	6423-43-4	3.9E+05	nm	1.6E+06	nm	2.8E-01	n	1.2E+00	n					
				7.0E-01	H					1	0.1		Propylene Glycol Monoethyl Ether	1569-02-4	4.3E+04	n	4.3E+05	nm					1.1E+04	n		2.2E+00	
				7.0E-01	H	2.0E+00	I			1	0.1		Propylene Glycol Monomethyl Ether	107-98-2	4.3E+04	n	4.3E+05	nm	2.1E+03	n	8.8E+03	n	1.1E+04	n		2.2E+00	
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1		7.8E+04	Propylene Oxide	75-56-9	2.0E+00	c	9.0E+00	c	6.6E-01	c*	3.3E+00	c*	2.3E-01	c		4.8E-05	
				2.5E-01	I					1	0.1		Pursuit	81335-77-5	1.5E+04	n	1.5E+05	nm					3.6E+03	n		3.2E+00	
				2.5E-02	I					1	0.1		Pydrin	51630-58-1	1.5E+03	n	1.5E+04	n					3.9E+02	n		2.5E+02	
				1.0E-03	I			V		1		5.3E+05	Pyridine	110-86-1	7.8E+01	n	1.0E+03	n					1.5E+01	n		5.3E-03	
				5.0E-04	I					1	0.1		Quinalphos	13593-03-8	3.1E+01	n	3.1E+02	n					3.8E+00	n		3.2E-02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Screening Levels												Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
3.0E+00	I									1	0.1		Quinoline	91-22-5	1.6E-01	c	5.7E-01	c					2.1E-02	c		6.8E-05	
						3.0E-02	A			1			Refractory Ceramic Fibers	NA	4.3E+07	nm	1.8E+08	nm	3.1E+01	n	1.3E+02	n					
				3.0E-02	I					1	0.1		Resmethrin	10453-86-8	1.8E+03	n	1.8E+04	n					4.8E+01	n		3.0E+01	
				5.0E-02	H					1	0.1		Ronnel	299-84-3	3.1E+03	n	3.1E+04	n					3.0E+02	n		2.7E+00	
				4.0E-03	I					1	0.1		Rotenone	83-79-4	2.4E+02	n	2.5E+03	n					4.7E+01	n		2.4E+01	
2.2E-01	C	6.3E-05	C						M	1	0.1		Safrole	94-59-7	5.2E-01	c	7.8E+00	c	1.5E-02	c	1.9E-01	c	8.3E-02	c		5.1E-05	
				2.5E-02	I					1	0.1		Savey	78587-05-0	1.5E+03	n	1.5E+04	n					8.1E+01	n		3.6E-01	
				5.0E-03	I					1			Selenious Acid	7783-00-8	3.9E+02	n	5.1E+03	n					7.8E+01	n			
				5.0E-03	I	2.0E-02	C			1			Selenium	7782-49-2	3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n	5.0E+01	4.0E-01	2.6E-01
				5.0E-03	C	2.0E-02	C			1			Selenium Sulfide	7446-34-6	3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n			
				9.0E-02	I					1	0.1		Sethoxydim	74051-80-2	5.5E+03	n	5.5E+04	n					7.8E+02	n		6.9E+00	
						3.0E-03	C			1			Silica (crystalline, respirable)	7631-86-9	4.3E+06	nm	1.8E+07	nm	3.1E+00	n	1.3E+01	n					
				5.0E-03	I					0.04			Silver	7440-22-4	3.9E+02	n	5.1E+03	n					7.1E+01	n		6.0E-01	
1.2E-01	H			5.0E-03	I					1	0.1		Simazine	122-34-9	4.1E+00	c*	1.4E+01	c					5.2E-01	c	4.0E+00	2.6E-04	2.0E-03
				1.3E-02	I					1	0.1		Sodium Acifluorfen	62476-59-9	7.9E+02	n	8.0E+03	n					2.0E+02	n		1.6E+00	
				4.0E-03	I					1			Sodium Azide	26628-22-8	3.1E+02	n	4.1E+03	n					6.2E+01	n			
2.7E-01	H			3.0E-02	I					1	0.1		Sodium Diethyldithiocarbamate	148-18-5	1.8E+00	c	6.4E+00	c					2.5E-01	c			
				5.0E-02	A	1.3E-02	C			1			Sodium Fluoride	7681-49-4	3.9E+03	n	5.1E+04	n	1.4E+01	n	5.7E+01	n	7.8E+02	n			
				2.0E-05	I					1	0.1		Sodium Fluoroacetate	62-74-8	1.2E+00	n	1.2E+01	n					3.1E-01	n		6.3E-05	
				1.0E-03	H					1			Sodium Metavanadate	13718-26-8	7.8E+01	n	1.0E+03	n					1.6E+01	n			
2.4E-02	H			3.0E-02	I					1	0.1		Stirofos (Tetrachlorovinphos)	961-11-5	2.0E+01	c*	7.2E+01	c					2.4E+00	c		7.0E-03	
				6.0E-01	I					1			Strontium, Stable	7440-24-6	4.7E+04	n	6.1E+05	nm					9.3E+03	n		3.3E+02	
				3.0E-04	I					1	0.1		Strychnine	57-24-9	1.8E+01	n	1.8E+02	n					4.6E+00	n		5.1E-02	
				2.0E-01	I	1.0E+00	I	V		1		8.7E+02	Styrene	100-42-5	6.3E+03	ns	3.6E+04	ns	1.0E+03	n	4.4E+03	n	1.1E+03	n	1.0E+02	1.2E+00	1.1E-01
				1.0E-03	P	2.0E-03	P			1	0.1		Sulfolane	126-33-0	6.1E+01	n	6.2E+02	n	2.1E+00	n	8.8E+00	n	1.6E+01	n		3.4E-03	
				8.0E-04	P					1	0.1		Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	4.9E+01	n	4.9E+02	n					8.3E+00	n		4.9E-02	
						1.0E-03	C			1			Sulfuric Acid	7664-93-9	1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n					
				2.5E-02	I					1	0.1		Systhane	88671-89-0	1.5E+03	n	1.5E+04	n					3.5E+02	n		4.3E+00	
				3.0E-02	H					1	0.1		TCMTB	21564-17-0	1.8E+03	n	1.8E+04	n					3.7E+02	n		2.6E+00	
				7.0E-02	I					1	0.1		Tebuthiuron	34014-18-1	4.3E+03	n	4.3E+04	n					1.1E+03	n		3.0E-01	
				2.0E-02	H					1	0.1		Temephos	3383-96-8	1.2E+03	n	1.2E+04	n					3.1E+02	n		6.0E+01	
				1.3E-02	I					1	0.1		Terbacil	5902-51-2	7.9E+02	n	8.0E+03	n					2.0E+02	n		5.9E-02	
				2.5E-05	H					1	0.1		Terbufos	13071-79-9	1.5E+00	n	1.5E+01	n					1.8E-01	n		3.9E-04	
				1.0E-03	I					1	0.1		Terbutryn	886-50-0	6.1E+01	n	6.2E+02	n					1.0E+01	n		1.4E-02	
				1.0E-04	I					1	0.1		Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	6.1E+00	n	6.2E+01	n					1.6E+00	n		4.2E-02	
				3.0E-04	I					1	0.1		Tetrachlorobenzene, 1,2,4,5-	95-94-3	1.8E+01	n	1.8E+02	n					1.2E+00	n		5.8E-03	
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		1		6.8E+02	Tetrachloroethane, 1,1,1,2-	630-20-6	1.9E+00	c	9.3E+00	c	3.3E-01	c	1.7E+00	c	5.0E-01	c		1.9E-04	
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		1		1.9E+03	Tetrachloroethane, 1,1,2,2-	79-34-5	5.6E-01	c	2.8E+00	c	4.2E-02	c	2.1E-01	c	6.6E-02	c		2.6E-05	
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		1		1.7E+02	Tetrachloroethylene	127-18-4	2.2E+01	c**	1.1E+02	c**	9.4E+00	c**	4.7E+01	c**	9.7E+00	c**	5.0E+00	4.4E-03	2.3E-03
				3.0E-02	I					1	0.1		Tetrachlorophenol, 2,3,4,6-	58-90-2	1.8E+03	n	1.8E+04	n					1.7E+02	n		1.1E+00	
2.0E+01	H									1	0.1		Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	2.4E-02	c	8.6E-02	c					1.1E-03	c		3.9E-06	
				5.0E-04	I					1	0.1		Tetraethyl Dithiopyrophosphate	3689-24-5	3.1E+01	n	3.1E+02	n					5.3E+00	n		3.9E-03	
						8.0E+01	I	V		1		1.1E+03	Tetrafluoroethane, 1,1,1,2-	811-97-2	1.1E+05	nms	4.6E+05	nms	8.3E+04	n	3.5E+05	n	1.7E+05	n		9.3E+01	
				4.0E-03	P					1	0.1		Tetryl (Trinitrophenylmethylnitramine)	479-45-8	2.4E+02	n	2.5E+03	n					6.1E+01	n		5.8E-01	
				7.0E-06	X					1			Thallium (I) Nitrate	10102-45-1	5.5E-01	n	7.2E+00	n					1.1E-01	n			
				1.0E-05	X					1			Thallium (Soluble Salts)	7440-28-0	7.8E-01	n	1.0E+01	n					1.6E-01	n	2.0E+00	1.1E-02	1.4E-01
				6.0E-06	X					1			Thallium Acetate	563-68-8	4.7E-01	n	6.1E+00	n					9.3E-02	n			
				2.0E-05	X					1			Thallium Carbonate	6533-73-9	1.6E+00	n	2.0E+01	n					3.1E-01	n			
				6.0E-06	X					1			Thallium Chloride	7791-12-0	4.7E-01	n	6.1E+00	n					9.3E-02	n			
				2.0E-05	X					1			Thallium Sulfate	7446-18-6	1.6E+00	n	2.0E+01	n					3.1E-01	n			
				1.0E-02	I					1	0.1		Thiobencarb	28249-77-6	6.1E+02	n	6.2E+03	n					1.2E+02	n		4.2E-01	
				7.0E-02	X					1	0.008		Thiodiglycol	111-48-8	5.4E+03	n	6.8E+04	n					1.1E+03	n		2.2E-01	
				3.0E-04	H					1	0.1		Thiofanox	39196-18-4	1.8E+01	n	1.8E+02	n					4.1E+00	n		1.4E-03	
				8.0E-02	I					1	0.1		Thiophanate, Methyl	23564-05-8	4.9E+03	n	4.9E+04	n					1.2E+03	n		1.1E+00	
				5.0E-03	I					1	0.1		Thiram	137-26-8	3.1E+02	n	3.1E+03	n					7.6E+01	n		1.1E-01	
				6.0E-01	H					1			Tin	7440-31-5	4.7E+04	n	6.1E+05	nm					9.3E+03	n		2.3E+03	
						1.0E-04	A			1			Titanium Tetrachloride	7550-45-0	1.4E+05	nm	6.0E+05	nm	1.0E-01	n	4.4E-01	n					
				8.0E-02	I	5.0E+00	I	V		1		8.2E+02	Toluene	108-88-3	5.0E+03	ns	4.5E+04	ns	5.2E+03	n	2.2E+04	n	8.6E+02	n	1.0E+03	5.9E-01	6.9E-01
1.8E-01	X			2.0E-04	X					1	0.1		Toluene-2,5-diamine	95-70-5	2.7E+00	c**	9.6E+00	c*					3.7E-01	c**		1.2E-04	
3.0E-02	P			4.0E-03	X					1	0.1		Toluidine, p-	106-49-0	1.6E+01	c*	5.7E+01	c*					2.2E+00	c*		9.2E-04	
1.1E+00	I	3.2E-04	I							1	0.1		Toxaphene	8001-35-2	4.4E-01	c	1.6E+00	c	7.6E-03	c	3.8E-02	c	1.3E-02	c	3.0E+00	2.1E-03	4.6E-01
				7.5E-03	I					1	0.1		Tralomethrin	66841-25-6	4.6E+02	n	4.6E+03	n					1.2E+02	n		4.5E+01	
				3.0E-04	A					1	0.1		Tri-n-butyltin	688-73-3	1.8E+01	n	1.8E+02	n					2.8E+00	n		6.2E-02	
				8.0E+01	X					1	0.1		Triacetin	102-76-1	4.9E+06	nm	4.9E+07	nm					1.2E+06	n		3.5E+02	
				1.3E-02	I					1	0.1		Triallate	2303-17-5	7.9E+02	n	8.0E+03	n					8.7E+01	n		1.9E-01	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Screening Levels										Protection of Ground Water SSLs	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.0E-02	I					1	0.1		Triasulfuron	82097-50-5	6.1E+02	n	6.2E+03	n					1.6E+02	n		1.6E-01	
				5.0E-03	I					1	0.1		Tribromobenzene, 1,2,4-	615-54-3	3.1E+02	n	3.1E+03	n					3.3E+01	n		4.7E-02	
9.0E-03	P			1.0E-02	P					1	0.1		Tributyl Phosphate	126-73-8	5.4E+01	c*	1.9E+02	c*					4.5E+00	c*		2.2E-02	
				3.0E-04	P					1	0.1		Tributyltin Compounds	NA	1.8E+01	n	1.8E+02	n					4.7E+00	n			
				3.0E-04	I					1	0.1		Tributyltin Oxide	56-35-9	1.8E+01	n	1.8E+02	n					4.4E+00	n		2.3E+02	
				3.0E+01	I	3.0E+01	H	V		1		9.1E+02	Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	4.3E+04	ns	1.8E+05	nms	3.1E+04	n	1.3E+05	n	5.3E+04	n		1.3E+02	
7.0E-02	I			2.0E-02	I					1	0.1		Trichloroacetic Acid	76-03-9	6.9E+00	c	2.5E+01	c					9.4E-01	c	6.0E+01	1.9E-04	1.2E-02
2.9E-02	H									1	0.1		Trichloroaniline HCl, 2,4,6-	33663-50-2	1.7E+01	c	5.9E+01	c					2.3E+00	c		6.4E-03	
7.0E-03	X			3.0E-05	X					1	0.1		Trichloroaniline, 2,4,6-	634-93-5	1.8E+00	n	1.8E+01	n					3.0E-01	n		2.7E-03	
				8.0E-04	X			V		1	0.1		Trichlorobenzene, 1,2,3-	87-61-6	4.9E+01	n	4.9E+02	n					5.2E+00	n		1.5E-02	
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1		4.0E+02	Trichlorobenzene, 1,2,4-	120-82-1	2.2E+01	c**	9.9E+01	c**	2.1E+00	n	8.8E+00	n	9.9E-01	c**	7.0E+01	2.9E-03	2.0E-01
				2.0E+00	I	5.0E+00	I	V		1		6.4E+02	Trichloroethane, 1,1,1-	71-55-6	8.7E+03	ns	3.8E+04	ns	5.2E+03	n	2.2E+04	n	7.5E+03	n	2.0E+02	2.6E+00	7.0E-02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1		2.2E+03	Trichloroethane, 1,1,2-	79-00-5	1.1E+00	c**	5.3E+00	c**	1.5E-01	c**	7.7E-01	c**	2.4E-01	c**	5.0E+00	7.7E-05	1.6E-03
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	1		6.9E+02	Trichloroethylene	79-01-6	9.1E-01	c**	6.4E+00	c**	4.3E-01	c**	3.0E+00	c**	4.4E-01	c**	5.0E+00	1.6E-04	1.8E-03
				3.0E-01	I	7.0E-01	H	V		1		1.2E+03	Trichlorofluoromethane	75-69-4	7.9E+02	n	3.4E+03	ns	7.3E+02	n	3.1E+03	n	1.1E+03	n		6.9E-01	
				1.0E-01	I					1	0.1		Trichlorophenol, 2,4,5-	95-95-4	6.1E+03	n	6.2E+04	n					8.9E+02	n		3.3E+00	
1.1E-02	I	3.1E-06	I	1.0E-03	P					1	0.1		Trichlorophenol, 2,4,6-	88-06-2	4.4E+01	c**	1.6E+02	c**	7.8E-01	c	4.0E+00	c	3.5E+00	c**		1.3E-02	
				1.0E-02	I					1	0.1		Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	6.1E+02	n	6.2E+03	n					1.2E+02	n		5.2E-02	
				8.0E-03	I					1	0.1		Trichlorophenoxypropionic acid, -2,4,5	93-72-1	4.9E+02	n	4.9E+03	n					8.4E+01	n	5.0E+01	4.6E-02	2.8E-02
				5.0E-03	I			V		1		1.3E+03	Trichloropropane, 1,1,2-	598-77-6	3.9E+02	n	5.1E+03	ns					6.8E+01	n		2.7E-02	
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1		1.4E+03	Trichloropropane, 1,2,3-	96-18-4	5.0E-03	c	9.5E-02	c	3.1E-01	n	1.3E+00	n	6.5E-04	c		2.8E-07	
				3.0E-03	X	3.0E-04	P	V		1		4.5E+02	Trichloropropene, 1,2,3-	96-19-5	7.8E-01	n	3.3E+00	n	3.1E-01	n	1.3E+00	n	6.2E-01	n		3.1E-04	
				2.0E-02	A					1	0.1		Tricresyl Phosphate (TCP)	1330-78-5	5.6E+03	n	3.1E+04	n					1.2E+02	n		1.1E+01	
				3.0E-03	I					1	0.1		Tridiphane	58138-08-2	1.8E+02	n	1.8E+03	n					1.3E+01	n		9.3E-02	
						7.0E-03	I	V		1		2.8E+04	Triethylamine	121-44-8	1.2E+02	n	5.2E+02	n	7.3E+00	n	3.1E+01	n	1.5E+01	n		4.4E-03	
7.7E-03	I			7.5E-03	I					1	0.1		Trifluralin	1582-09-8	6.3E+01	c**	2.2E+02	c*					2.2E+00	c*		7.2E-02	
2.0E-02	P			1.0E-02	P					1	0.1		Trimethyl Phosphate	512-56-1	2.4E+01	c*	8.6E+01	c*					3.4E+00	c*		7.4E-04	
						5.0E-03	P	V		1		2.9E+02	Trimethylbenzene, 1,2,3-	526-73-8	5.3E+01	n	2.2E+02	n	5.2E+00	n	2.2E+01	n	1.0E+01	n		1.5E-02	
						7.0E-03	P	V		1		2.2E+02	Trimethylbenzene, 1,2,4-	95-63-6	6.2E+01	n	2.6E+02	ns	7.3E+00	n	3.1E+01	n	1.5E+01	n		2.1E-02	
				1.0E-02	X			V		1		1.8E+02	Trimethylbenzene, 1,3,5-	108-67-8	7.8E+02	ns	1.0E+04	ns					8.7E+01	n		1.2E-01	
				3.0E-02	I					1	0.019		Trinitrobenzene, 1,3,5-	99-35-4	2.2E+03	n	2.7E+04	n					4.6E+02	n		1.7E+00	
3.0E-02	I			5.0E-04	I					1	0.032		Trinitrotoluene, 2,4,6-	118-96-7	1.9E+01	c**	7.9E+01	c**					2.2E+00	c**		1.3E-02	
				2.0E-02	P					1	0.1		Triphenylphosphine Oxide	791-28-6	1.2E+03	n	1.2E+04	n					2.8E+02	n		1.2E+00	
				2.0E-02	A					1	0.1		Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8	1.2E+03	n	1.2E+04	n					2.8E+02	n		6.2E+00	
				1.0E-02	X					1	0.1		Tris(1-chloro-2-propyl)phosphate	13674-84-5	6.1E+02	n	6.2E+03	n					1.5E+02	n		5.0E-01	
2.0E-02	P			7.0E-03	P					1	0.1		Tris(2-chloroethyl)phosphate	115-96-8	2.4E+01	c*	8.6E+01	c*					3.3E+00	c*		3.2E-03	
3.2E-03	P			1.0E-01	P					1	0.1		Tris(2-ethylhexyl)phosphate	78-42-2	1.5E+02	c*	5.4E+02	c					2.1E+01	c*		1.0E+02	
				3.0E-03	I	4.0E-05	A			1			Uranium (Soluble Salts)	NA	2.3E+02	n	3.0E+03	n	4.2E-02	n	1.8E-01	n	4.7E+01	n	3.0E+01	2.1E+01	1.4E+01
1.0E+00	C	2.9E-04	C						M	1	0.1		Urethane	51-79-6	1.2E-01	c	1.7E+00	c	3.3E-03	c	4.2E-02	c	2.1E-02	c		4.8E-06	
		8.3E-03	P	9.0E-03	I	7.0E-06	P			0.026			Vanadium Pentoxide	1314-62-1	4.0E+02	c**	2.0E+03	c**	2.9E-04	c*	1.5E-03	c*	1.1E+02	n			
				5.0E-03	S	1.0E-04	A			0.026			Vanadium and Compounds	7440-62-2	3.9E+02	n	5.1E+03	n	1.0E-01	n	4.4E-01	n	6.3E+01	n		6.3E+01	
				1.0E-03	I					1	0.1		Vernolate	1929-77-7	6.1E+01	n	6.2E+02	n					8.3E+00	n		6.6E-03	
				2.5E-02	I					1	0.1		Vinclozolin	50471-44-8	1.5E+03	n	1.5E+04	n					3.4E+02	n		2.6E-01	
				1.0E+00	H	2.0E-01	I	V		1		2.8E+03	Vinyl Acetate	108-05-4	9.7E+02	n	4.1E+03	ns	2.1E+02	n	8.8E+02	n	4.1E+02	n		8.7E-02	
		3.2E-05	H			3.0E-03	I	V		1		3.4E+03	Vinyl Bromide	593-60-2	1.1E-01	c*	5.6E-01	c*	7.6E-02	c*	3.8E-01	c*	1.5E-01	c*		4.4E-05	
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1		3.9E+03	Vinyl Chloride	75-01-4	6.0E-02	c	1.7E+00	c	1.6E-01	c	2.8E+00	c	1.5E-02	c	2.0E+00	5.3E-06	6.9E-04
				3.0E-04	I					1	0.1		Warfarin	81-81-2	1.8E+01	n	1.8E+02	n					4.4E+00	n		4.6E-03	
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	Xylene, P-	106-42-3	6.0E+02	ns	2.6E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.8E-01	
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	Xylene, m-	108-38-3	5.9E+02	ns	2.5E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.8E-01	
				2.0E-01	S	1.0E-01	S	V		1		4.3E+02	Xylene, o-	95-47-6	6.9E+02	ns	3.0E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.9E-01	
				2.0E-01	I	1.0E-01	I	V		1		2.6E+02	Xylenes	1330-20-7	6.3E+02	ns	2.7E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n	1.0E+04	1.9E-01	9.8E+00
				3.0E-04	I					1			Zinc Phosphide	1314-84-7	2.3E+01	n	3.1E+02	n					4.7E+00	n			
				3.0E-01	I					1			Zinc and Compounds	7440-66-6	2.3E+04	n	3.1E+05	nm					4.7E+03	n		2.9E+02	
				5.0E-02	I					1	0.1		Zineb	12122-67-7	3.1E+03	n	3.1E+04	n					7.7E+02	n		2.2E+00	
				8.0E-05	X					1			Zirconium	7440-67-7	6.3E+00	n	8.2E+01	n					1.2E+00	n		3.7E+00	

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
1.8E-02	C	5.1E-06	C	1.5E-01	I					1	0.1		1.4E+09		ALAR	1596-84-5	3.6E+01	1.1E+02	6.5E+05	2.7E+01	1.2E+04	4.2E+04		9.2E+03
8.7E-03	I			4.0E-03	I					1	0.1		1.4E+09		Acephate	30560-19-1	7.4E+01	2.3E+02		5.6E+01	3.1E+02	1.1E+03		2.4E+02
		2.2E-06	I			9.0E-03	I	V		1		1.1E+05	1.4E+09	9.4E+03	Acetaldehyde	75-07-0			1.0E+01	1.0E+01			8.8E+01	8.8E+01
				2.0E-02	I					1	0.1		1.4E+09		Acetochlor	34256-82-1					1.6E+03	5.6E+03		1.2E+03
				9.0E-01	I	3.1E+01	A	V		1		1.1E+05	1.4E+09	1.5E+04	Acetone	67-64-1					7.0E+04		4.7E+05	6.1E+04
						2.0E-03	X	V		1		1.1E+05	1.4E+09	2.6E+04	Acetone Cyanohydrin	75-86-5							5.3E+01	5.3E+01
						6.0E-02	I	V		1		1.3E+05	1.4E+09	1.4E+04	Acetonitrile	75-05-8							8.7E+02	8.7E+02
				1.0E-01	I			V		1		2.5E+03	1.4E+09	6.4E+04	Acetophenone	98-86-2					7.8E+03			7.8E+03
3.8E+00	C	1.3E-03	C							1	0.1		1.4E+09		Acetylaminofluorene, 2-	53-96-3	1.7E-01	5.3E-01	2.5E+03	1.3E-01				
				5.0E-04	I	2.0E-05	I	V		1		2.3E+04	1.4E+09	7.4E+03	Acrolein	107-02-8					3.9E+01		1.6E-01	1.5E-01
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	1	0.1		1.4E+09		Acrylamide	79-06-1	3.0E-01	1.0E+00	1.3E+04	2.3E-01	1.6E+02	5.6E+02	8.5E+06	1.2E+02
				5.0E-01	I	1.0E-03	I			1	0.1		1.4E+09		Acrylic Acid	79-10-7					3.9E+04	1.4E+05	1.4E+06	3.0E+04
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		1		1.1E+04	1.4E+09	8.3E+03	Acrylonitrile	107-13-1	1.2E+00		3.0E-01	2.4E-01	3.1E+03		1.7E+01	1.7E+01
						6.0E-03	P			1	0.1		1.4E+09		Adiponitrile	111-69-3							8.5E+06	8.5E+06
5.6E-02	C			1.0E-02	I					1	0.1		1.4E+09		Alachlor	15972-60-8	1.1E+01	3.6E+01		8.7E+00	7.8E+02	2.8E+03		6.1E+02
				1.0E-03	I					1	0.1		1.4E+09		Aldicarb	116-06-3					7.8E+01	2.8E+02		6.1E+01
				1.0E-03	I					1	0.1		1.4E+09		Aldicarb Sulfone	1646-88-4					7.8E+01	2.8E+02		6.1E+01
										1	0.1		1.4E+09		Aldicarb sulfoxide	1646-87-3								
1.7E+01	I	4.9E-03	I	3.0E-05	I					1	0.1		1.4E+09		Aldrin	309-00-2	3.8E-02	1.2E-01	6.8E+02	2.9E-02	2.3E+00	8.4E+00		1.8E+00
				2.5E-01	I					1	0.1		1.4E+09		Ally	74223-64-6					2.0E+04	7.0E+04		1.5E+04
				5.0E-03	I	1.0E-04	X			1	0.1		1.4E+09		Allyl Alcohol	107-18-6					3.9E+02	1.4E+03	1.4E+05	3.0E+02
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1		1.4E+03	1.4E+09	1.7E+03	Allyl Chloride	107-05-1	3.0E+01		6.9E-01	6.8E-01			1.8E+00	1.8E+00
				1.0E+00	P	5.0E-03	P			1			1.4E+09		Aluminum	7429-90-5					7.8E+04		7.1E+06	7.7E+04
				4.0E-04	I					1			1.4E+09		Aluminum Phosphide	20859-73-8					3.1E+01			3.1E+01
				3.0E-04	I					1	0.1		1.4E+09		Amdro	67485-29-4					2.3E+01	8.4E+01		1.8E+01
				9.0E-03	I					1	0.1		1.4E+09		Ametryn	834-12-8					7.0E+02	2.5E+03		5.5E+02
2.1E+01	C	6.0E-03	C							1	0.1		1.4E+09		Aminobiphenyl, 4-	92-67-1	3.0E-02	9.6E-02	5.5E+02	2.3E-02				
				8.0E-02	P					1	0.1		1.4E+09		Aminophenol, m-	591-27-5					6.3E+03	2.2E+04		4.9E+03
				2.0E-02	P					1	0.1		1.4E+09		Aminophenol, p-	123-30-8					1.6E+03	5.6E+03		1.2E+03
				2.5E-03	I					1	0.1		1.4E+09		Amitraz	33089-61-1					2.0E+02	7.0E+02		1.5E+02
						1.0E-01	I			1					Ammonia	7664-41-7								
				2.0E-01	I					1			1.4E+09		Ammonium Sulfamate	7773-06-0					1.6E+04			1.6E+04
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			1	0.1		1.4E+09		Aniline	62-53-3	1.1E+02	3.5E+02	2.1E+06	8.5E+01	5.5E+02	2.0E+03	1.4E+06	4.3E+02
4.0E-02	P			2.0E-03	X					1	0.1		1.4E+09		Anthraquinone, 9,10-	84-65-1	1.6E+01	5.1E+01		1.2E+01	1.6E+02	5.6E+02		1.2E+02
				4.0E-04	I					0.15			1.4E+09		Antimony (metallic)	7440-36-0					3.1E+01			3.1E+01
				5.0E-04	H					0.15			1.4E+09		Antimony Pentoxide	1314-60-9					3.9E+01			3.9E+01
				9.0E-04	H					0.15			1.4E+09		Antimony Potassium Tartrate	11071-15-1					7.0E+01			7.0E+01
				4.0E-04	H					0.15			1.4E+09		Antimony Tetroxide	1332-81-6					3.1E+01			3.1E+01
						2.0E-04	I			0.15			1.4E+09		Antimony Trioxide	1309-64-4							2.8E+05	2.8E+05
				1.3E-02	I					1	0.1		1.4E+09		Apollo	74115-24-5					1.0E+03	3.6E+03		7.9E+02
2.5E-02	I	7.1E-06	I	5.0E-02	H					1	0.1		1.4E+09		Aramite	140-57-8	2.6E+01	8.1E+01	4.7E+05	1.9E+01	3.9E+03	1.4E+04		3.1E+03
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			1	0.03		1.4E+09		Arsenic, Inorganic	7440-38-2	7.1E-01	4.5E+00	7.7E+02	6.1E-01	3.9E+01	2.8E+02	2.1E+04	3.4E+01
				3.5E-06	C	5.0E-05	I			1			1.4E+09		Arsine	7784-42-1					2.7E-01		7.1E+04	2.7E-01
				9.0E-03	I					1	0.1		1.4E+09		Assure	76578-14-8					7.0E+02	2.5E+03		5.5E+02
				5.0E-02	I					1	0.1		1.4E+09		Asulam	3337-71-1					3.9E+03	1.4E+04		3.1E+03
2.3E-01	C			3.5E-02	I					1	0.1		1.4E+09		Atrazine	1912-24-9	2.8E+00	8.8E+00		2.1E+00	2.7E+03	9.8E+03		2.1E+03
8.8E-01	C	2.5E-04	C							1	0.1		1.4E+09		Auramine	492-80-8	7.3E-01	2.3E+00	1.3E+04	5.5E-01				
				4.0E-04	I					1	0.1		1.4E+09		Avermectin B1	65195-55-3					3.1E+01	1.1E+02		2.4E+01
1.1E-01	I	3.1E-05	I					V		1			1.4E+09	5.6E+05	Azobenzene	103-33-3	5.8E+00		4.4E+01	5.1E+00				
				2.0E-01	I	5.0E-04	H			0.07			1.4E+09		Barium	7440-39-3					1.6E+04		7.1E+05	1.5E+04
				4.0E-03	I					1	0.1		1.4E+09		Baygon	114-26-1					3.1E+02	1.1E+03		2.4E+02
				3.0E-02	I					1	0.1		1.4E+09		Bayleton	43121-43-3					2.3E+03	8.4E+03		1.8E+03
				2.5E-02	I					1	0.1		1.4E+09		Baythroid	68359-37-5					2.0E+03	7.0E+03		1.5E+03
				3.0E-01	I					1	0.1		1.4E+09		Benefin	1861-40-1					2.3E+04	8.4E+04		1.8E+04
				5.0E-02	I					1	0.1		1.4E+09		Benomyl	17804-35-2					3.9E+03	1.4E+04		3.1E+03
				3.0E-02	I					1	0.1		1.4E+09		Bentazon	25057-89-0					2.3E+03	8.4E+03		1.8E+03
				1.0E-01	I			V		1		1.2E+03	1.4E+09	2.4E+04	Benzaldehyde	100-52-7					7.8E+03			7.8E+03
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1		1.8E+03	1.4E+09	3.8E+03	Benzene	71-43-2	1.2E+01		1.2E+00	1.1E+00	3.1E+02		1.2E+02	8.6E+01
1.0E-01	X			3.0E-04	X					1	0.1		1.4E+09		Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	6.4E+00	2.0E+01		4.9E+00	2.3E+01	8.4E+01		1.8E+01
				1.0E-03	P			V		1		1.3E+03	1.4E+09	2.1E+04	Benzenethiol	108-98-5					7.8E+01			7.8E+01
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1	0.1		1.4E+09		Benzidine	92-87-5	6.5E-04	2.2E-03	1.9E+01	5.0E-04	2.3E+02	8.4E+02		1.8E+02
				4.0E+00	I					1	0.1		1.4E+09		Benzoic Acid	65-85-0					3.1E+05	1.1E+06		2.4E+05
1.3E+01	I							V		1		3.2E+02	1.4E+09	7.3E+04	Benzotrichloride	98-07-7	4.9E-02			4.9E-02				
				1.0E-01	P					1	0.1		1.4E+09		Benzyl Alcohol	100-51-6					7.8E+03	2.8E+04		6.1E+03
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1		1.5E+03	1.4E+09	2.7E+04	Benzyl Chloride	100-44-7	3.8E+00		1.4E+00	1.0E+00	1.6E+02		2.9E+01	2.4E+01

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
		2.4E-03	I	2.0E-03	I	2.0E-05	I			0.007			1.4E+09		Beryllium and compounds	7440-41-7			1.4E+03	1.4E+03	1.6E+02		2.8E+04	1.6E+02
				1.0E-04	I					1	0.1		1.4E+09		Bidrin	141-66-2					7.8E+00	2.8E+01		6.1E+00
				9.0E-03	P					1	0.1		1.4E+09		Bifenox	42576-02-3					7.0E+02	2.5E+03		5.5E+02
				1.5E-02	I					1	0.1		1.4E+09		Biphenthrin	82657-04-3					1.2E+03	4.2E+03		9.2E+02
8.0E-03	X			5.0E-02	I	4.0E-04	X	V		1			1.4E+09	1.2E+05	Biphenyl, 1,1'-	92-52-4	8.0E+01			8.0E+01	3.9E+03		5.1E+01	5.1E+01
7.0E-02	H	1.0E-05	H	4.0E-02	I			V		1		1.0E+03	1.4E+09	3.8E+04	Bis(2-chloro-1-methylethyl) ether	108-60-1	9.1E+00		9.2E+00	4.6E+00	3.1E+03			3.1E+03
				3.0E-03	P					1	0.1		1.4E+09		Bis(2-chloroethoxy)methane	111-91-1					2.3E+02	8.4E+02		1.8E+02
1.1E+00	I	3.3E-04	I					V		1		5.1E+03	1.4E+09	4.6E+04	Bis(2-chloroethyl)ether	111-44-4	5.8E-01		3.4E-01	2.1E-01				
1.4E-02	I	2.4E-06	C	2.0E-02	I					1	0.1		1.4E+09		Bis(2-ethylhexyl)phthalate	117-81-7	4.6E+01	1.4E+02	1.4E+06	3.5E+01	1.6E+03	5.6E+03		1.2E+03
2.2E+02	I	6.2E-02	I					V		1		4.2E+03	1.4E+09	2.0E+03	Bis(chloromethyl)ether	542-88-1	2.9E-03		7.9E-05	7.7E-05				
				5.0E-02	I					1	0.1		1.4E+09		Bisphenol A	80-05-7					3.9E+03	1.4E+04		3.1E+03
				2.0E-01	I	2.0E-02	H			1			1.4E+09		Boron And Borates Only	7440-42-8					1.6E+04		2.8E+07	1.6E+04
				2.0E+00	P	2.0E-02	P			1			1.4E+09		Boron Trichloride	10294-34-5					1.6E+05		2.8E+07	1.6E+05
				4.0E-02	C	1.3E-02	C			1			1.4E+09		Boron Trifluoride	7637-07-2					3.1E+03		1.8E+07	3.1E+03
7.0E-01	I			4.0E-03	I					1			1.4E+09		Bromate	15541-45-4	9.1E-01			9.1E-01	3.1E+02			3.1E+02
2.0E+00	X	6.0E-04	X					V		1		2.4E+03	1.4E+09	6.4E+03	Bromo-2-chloroethane, 1-	107-04-0	3.2E-01		2.6E-02	2.4E-02				
				8.0E-03	I	6.0E-02	I	V		1		6.8E+02	1.4E+09	9.0E+03	Bromobenzene	108-86-1					6.3E+02		5.6E+02	3.0E+02
						4.0E-02	X	V		1		4.0E+03	1.4E+09	3.9E+03	Bromochloromethane	74-97-5							1.6E+02	1.6E+02
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		1		9.3E+02	1.4E+09	4.3E+03	Bromodichloromethane	75-27-4	1.0E+01		2.8E-01	2.7E-01	1.6E+03			1.6E+03
7.9E-03	I	1.1E-06	I	2.0E-02	I					1	0.1		1.4E+09		Bromoform	75-25-2	8.1E+01	2.6E+02	3.0E+06	6.2E+01	1.6E+03	5.6E+03		1.2E+03
				1.4E-03	I	5.0E-03	I	V		1		3.6E+03	1.4E+09	1.5E+03	Bromomethane	74-83-9					1.1E+02		7.8E+00	7.3E+00
				5.0E-03	H					1	0.1		1.4E+09		Bromophos	2104-96-3					3.9E+02	1.4E+03		3.1E+02
				2.0E-02	I					1	0.1		1.4E+09		Bromoxynil	1689-84-5					1.6E+03	5.6E+03		1.2E+03
				2.0E-02	I					1	0.1		1.4E+09		Bromoxynil Octanoate	1689-99-2					1.6E+03	5.6E+03		1.2E+03
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1		6.7E+02	1.4E+09	9.3E+02	Butadiene, 1,3-	106-99-0	1.9E-01		7.6E-02	5.4E-02			1.9E+00	1.9E+00
				1.0E-01	I					1	0.1		1.4E+09		Butanol, N-	71-36-3					7.8E+03	2.8E+04		6.1E+03
1.9E-03	P			2.0E-01	I					1	0.1		1.4E+09		Butyl Benzyl Phthlate	85-68-7	3.4E+02	1.1E+03		2.6E+02	1.6E+04	5.6E+04		1.2E+04
				2.0E+00	P	3.0E+01	P			1	0.1		1.4E+09		Butyl alcohol, sec-	78-92-2					1.6E+05	5.6E+05	4.3E+10	1.2E+05
				5.0E-02	I					1	0.1		1.4E+09		Butylate	2008-41-5					3.9E+03	1.4E+04		3.1E+03
2.0E-04	C	5.7E-08	C							1	0.1		1.4E+09		Butylated hydroxyanisole	25013-16-5	3.2E+03	1.0E+04	5.8E+07	2.4E+03				
				5.0E-02	P			V		1		1.1E+02	1.4E+09	8.8E+03	Butylbenzene, n-	104-51-8					3.9E+03			3.9E+03
				1.0E-01	X			V		1		1.5E+02	1.4E+09	7.9E+03	Butylbenzene, sec-	135-98-8					7.8E+03			7.8E+03
				1.0E-01	X			V		1		1.8E+02	1.4E+09	7.9E+03	Butylbenzene, tert-	98-06-6					7.8E+03			7.8E+03
				1.0E+00	I					1	0.1		1.4E+09		Butylphthalyl Butylglycolate	85-70-1					7.8E+04	2.8E+05		6.1E+04
				2.0E-02	A					1	0.1		1.4E+09		Cacodylic Acid	75-60-5					1.6E+03	5.6E+03		1.2E+03
		1.8E-03	I	1.0E-03	I	1.0E-05	A			0.025	0.001		1.4E+09		Cadmium (Diet)	7440-43-9			1.8E+03	1.8E+03	7.8E+01	7.0E+02	1.4E+04	7.0E+01
		1.8E-03	I	5.0E-04	I	1.0E-05	A			0.05	0.001				Cadmium (Water)	7440-43-9								
				5.0E-01	I					1	0.1		1.4E+09		Caprolactam	105-60-2					3.9E+04	1.4E+05		3.1E+04
1.5E-01	C	4.3E-05	C	2.0E-03	I					1	0.1		1.4E+09		Captafol	2425-06-1	4.3E+00	1.3E+01	7.7E+04	3.2E+00	1.6E+02	5.6E+02		1.2E+02
2.3E-03	C	6.6E-07	C	1.3E-01	I					1	0.1		1.4E+09		Captan	133-06-2	2.8E+02	8.8E+02	5.0E+06	2.1E+02	1.0E+04	3.6E+04		7.9E+03
				1.0E-01	I					1	0.1		1.4E+09		Carbaryl	63-25-2					7.8E+03	2.8E+04		6.1E+03
				5.0E-03	I					1	0.1		1.4E+09		Carbofuran	1563-66-2					3.9E+02	1.4E+03		3.1E+02
				1.0E-01	I	7.0E-01	I	V		1		7.4E+02	1.4E+09	1.3E+03	Carbon Disulfide	75-15-0					7.8E+03		9.2E+02	8.2E+02
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		1		4.6E+02	1.4E+09	1.6E+03	Carbon Tetrachloride	56-23-5	9.1E+00		6.5E-01	6.1E-01	3.1E+02		1.7E+02	1.1E+02
				1.0E-02	I					1	0.1		1.4E+09		Carbosulfan	55285-14-8					7.8E+02	2.8E+03		6.1E+02
				1.0E-01	I					1	0.1		1.4E+09		Carboxin	5234-68-4					7.8E+03	2.8E+04		6.1E+03
						9.0E-04	I			1			1.4E+09		Ceric oxide	1306-38-3							1.3E+06	1.3E+06
				1.0E-01	I					1	0.1		1.4E+09		Chloral Hydrate	302-17-0					7.8E+03	2.8E+04		6.1E+03
				1.5E-02	I					1	0.1		1.4E+09		Chloramben	133-90-4					1.2E+03	4.2E+03		9.2E+02
4.0E-01	H									1	0.1		1.4E+09		Chloranil	118-75-2	1.6E+00	5.0E+00		1.2E+00				
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			1	0.04		1.4E+09		Chlordane	12789-03-6	1.8E+00	1.4E+01	3.3E+04	1.6E+00	3.9E+01	3.5E+02	9.9E+05	3.5E+01
1.0E+01	I	4.6E-03	C	3.0E-04	I					1	0.1		1.4E+09		Chlordecone (Kepone)	143-50-0	6.4E-02	2.0E-01	7.2E+02	4.9E-02	2.3E+01	8.4E+01		1.8E+01
				7.0E-04	A					1	0.1		1.4E+09		Chlorfenvinphos	470-90-6					5.5E+01	2.0E+02		4.3E+01
				2.0E-02	I					1	0.1		1.4E+09		Chlorimuron, Ethyl-	90982-32-4					1.6E+03	5.6E+03		1.2E+03
				1.0E-01	I	1.5E-04	A			1			1.4E+09		Chlorine	7782-50-5					7.8E+03		2.1E+05	7.5E+03
				3.0E-02	I	2.0E-04	I			1			1.4E+09		Chlorine Dioxide	10049-04-4					2.3E+03		2.8E+05	2.3E+03
				3.0E-02	I					1			1.4E+09		Chlorite (Sodium Salt)	7758-19-2					2.3E+03			2.3E+03
						5.0E+01	I	V		1		1.2E+03	1.4E+09	1.1E+03	Chloro-1,1-difluoroethane, 1-	75-68-3							5.8E+04	5.8E+04
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		1		7.5E+02	1.4E+09	1.2E+03	Chloro-1,3-butadiene, 2-	126-99-8			9.4E-03	9.4E-03	1.6E+03		2.4E+01	2.4E+01
4.6E-01	H									1	0.1		1.4E+09		Chloro-2-methylaniline HCl, 4-	3165-93-3	1.4E+00	4.4E+00		1.1E+00				
1.0E-01	P	7.7E-05	C	3.0E-03	X					1	0.1		1.4E+09		Chloro-2-methylaniline, 4-	95-69-2	6.4E+00	2.0E+01	4.3E+04	4.9E+00	2.3E+02	8.4E+02		1.8E+02
2.7E-01	X							V		1	0.1	2.8E+04	1.4E+09	2.0E+04	Chloroacetaldehyde, 2-	107-20-0	2.4E+00	7.5E+00		1.8E+00				
				2.0E-03	H					1	0.1		1.4E+09		Chloroacetic Acid	79-11-8					1.6E+02	5.6E+02		1.2E+02
						3.0E-05	I			1	0.1		1.4E+09		Chloroacetophenone, 2-	532-27-4							4.3E+04	4.3E+04
2.0E-01	P			4.0E-03	I					1	0.1		1.4E+09		Chloroaniline, p-	106-47-8	3.2E+00	1.0E+01		2.4E+00	3.1E+02	1.1E+03		2.4E+02

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-02	I	5.0E-02	P	V		1		7.6E+02	1.4E+09	6.9E+03	Chlorobenzene	108-90-7					1.6E+03		3.6E+02	2.9E+02
1.1E-01	C	3.1E-05	C	2.0E-02	I					1	0.1		1.4E+09		Chlorobenzilate	510-15-6	5.8E+00	1.8E+01	1.1E+05	4.4E+00	1.6E+03	5.6E+03		1.2E+03
				3.0E-02	X					1	0.1		1.4E+09		Chlorobenzoic Acid, p-	74-11-3					2.3E+03	8.4E+03		1.8E+03
				3.0E-03	P	3.0E-01	P	V		1		1.2E+02	1.4E+09	7.3E+03	Chlorobenzotrifluoride, 4-	98-56-6					2.3E+02		2.3E+03	2.1E+02
				4.0E-02	P			V		1		7.3E+02	1.4E+09	1.9E+03	Chlorobutane, 1-	109-69-3					3.1E+03			3.1E+03
						5.0E+01	I	V		1		1.7E+03	1.4E+09	1.0E+03	Chlorodifluoromethane	75-45-6							5.3E+04	5.3E+04
				2.0E-02	P					1	0.1		1.4E+09		Chloroethanol, 2-	107-07-3					1.6E+03	5.6E+03		1.2E+03
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1		2.5E+03	1.4E+09	2.8E+03	Chloroform	67-66-3	2.1E+01		3.0E-01	2.9E-01	7.8E+02		2.9E+02	2.1E+02
						9.0E-02	I	V		1		1.3E+03	1.4E+09	1.3E+03	Chloromethane	74-87-3							1.2E+02	1.2E+02
2.4E+00	C	6.9E-04	C					V		1		2.6E+04	1.4E+09	5.7E+03	Chloromethyl Methyl Ether	107-30-2	2.7E-01		2.0E-02	1.9E-02				
				8.0E-02	I			V		1			1.4E+09	8.6E+04	Chloronaphthalene, Beta-	91-58-7					6.3E+03			6.3E+03
3.0E-01	P			3.0E-03	P	1.0E-05	X			1	0.1		1.4E+09		Chloronitrobenzene, o-	88-73-3	2.1E+00	6.7E+00		1.6E+00	2.3E+02	8.4E+02	1.4E+04	1.8E+02
6.3E-03	P			1.0E-03	P	6.0E-04	P			1	0.1		1.4E+09		Chloronitrobenzene, p-	100-00-5	1.0E+02	3.2E+02		7.7E+01	7.8E+01	2.8E+02	8.5E+05	6.1E+01
				5.0E-03	I			V		1		2.2E+04	1.4E+09	1.3E+05	Chlorophenol, 2-	95-57-8					3.9E+02			3.9E+02
						4.0E-04	C	V		1		6.2E+02	1.4E+09	5.0E+03	Chloropicrin	76-06-2							2.1E+00	2.1E+00
3.1E-03	C	8.9E-07	C	1.5E-02	I					1	0.1		1.4E+09		Chlorothalonil	1897-45-6	2.1E+02	6.5E+02	3.7E+06	1.6E+02	1.2E+03	4.2E+03		9.2E+02
				2.0E-02	I			V		1		9.1E+02	1.4E+09	8.7E+03	Chlorotoluene, o-	95-49-8					1.6E+03			1.6E+03
				2.0E-02	X			V		1		2.5E+02	1.4E+09	7.9E+03	Chlorotoluene, p-	106-43-4					1.6E+03			1.6E+03
2.4E+02	C	6.9E-02	C							1	0.1		1.4E+09		Chlorozotocin	54749-90-5	2.7E-03	8.4E-03	4.8E+01	2.0E-03				
				2.0E-01	I					1	0.1		1.4E+09		Chlorpropham	101-21-3					1.6E+04	5.6E+04		1.2E+04
				1.0E-03	A					1	0.1		1.4E+09		Chlorpyrifos	2921-88-2					7.8E+01	2.8E+02		6.1E+01
				1.0E-02	H					1	0.1		1.4E+09		Chlorpyrifos Methyl	5598-13-0					7.8E+02	2.8E+03		6.1E+02
				5.0E-02	I					1	0.1		1.4E+09		Chlorsulfuron	64902-72-3					3.9E+03	1.4E+04		3.1E+03
				8.0E-04	H					1	0.1		1.4E+09		Chlorthiophos	60238-56-4					6.3E+01	2.2E+02		4.9E+01
				1.5E+00	I					0.013			1.4E+09		Chromium(III), Insoluble Salts	16065-83-1					1.2E+05			1.2E+05
5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I		M	0.025			1.4E+09		Chromium(VI)	18540-29-9	3.0E-01		1.6E+01	2.9E-01	2.3E+02		1.4E+05	2.3E+02
										0.013			1.4E+09		Chromium, Total	7440-47-3								
		9.0E-03	P	3.0E-04	P	6.0E-06	P			1			1.4E+09		Cobalt	7440-48-4			3.7E+02	3.7E+02	2.3E+01		8.5E+03	2.3E+01
		6.2E-04	I						M	1	0.1				Coke Oven Emissions	8007-45-2								
				4.0E-02	H					1			1.4E+09		Copper	7440-50-8					3.1E+03			3.1E+03
				5.0E-02	I	6.0E-01	C			1	0.1		1.4E+09		Cresol, m-	108-39-4					3.9E+03	1.4E+04	8.5E+08	3.1E+03
				5.0E-02	I	6.0E-01	C			1	0.1		1.4E+09		Cresol, o-	95-48-7					3.9E+03	1.4E+04	8.5E+08	3.1E+03
				1.0E-01	A	6.0E-01	C			1	0.1		1.4E+09		Cresol, p-	106-44-5					7.8E+03	2.8E+04	8.5E+08	6.1E+03
				1.0E-01	A					1	0.1		1.4E+09		Cresol, p-chloro-m-	59-50-7					7.8E+03	2.8E+04		6.1E+03
				1.0E-01	A	6.0E-01	C			1	0.1		1.4E+09		Cresols	1319-77-3					7.8E+03	2.8E+04	8.5E+08	6.1E+03
1.9E+00	H			1.0E-03	P			V		1		1.7E+04	1.4E+09	2.0E+04	Crotonaldehyde, trans-	123-73-9	3.4E-01			3.4E-01	7.8E+01			7.8E+01
				1.0E-01	I	4.0E-01	I	V		1		2.7E+02	1.4E+09	6.7E+03	Cumene	98-82-8					7.8E+03		2.8E+03	2.1E+03
2.2E-01	C	6.3E-05	C							1	0.1		1.4E+09		Cupferron	135-20-6	2.9E+00	9.2E+00	5.3E+04	2.2E+00				
8.4E-01	H			2.0E-03	H					1	0.1		1.4E+09		Cyanazine	21725-46-2	7.6E-01	2.4E+00		5.8E-01	1.6E+02	5.6E+02		1.2E+02
															Cyanides									
				1.0E-03	I					1			1.4E+09		~Calcium Cyanide	592-01-8					7.8E+01			7.8E+01
				5.0E-03	I					1			1.4E+09		~Copper Cyanide	544-92-3					3.9E+02			3.9E+02
				6.0E-04	I	8.0E-04	S	V		1		1.0E+07	1.4E+09	5.0E+04	~Cyanide (CN-)	57-12-5					4.7E+01		4.2E+01	2.2E+01
				1.0E-03	I			V		1			1.4E+09		~Cyanogen	460-19-5					7.8E+01			7.8E+01
				9.0E-02	I			V		1			1.4E+09		~Cyanogen Bromide	506-68-3					7.0E+03			7.0E+03
				5.0E-02	I			V		1			1.4E+09		~Cyanogen Chloride	506-77-4					3.9E+03			3.9E+03
				6.0E-04	I	8.0E-04	I	V		1		1.0E+07	1.4E+09	5.6E+04	~Hydrogen Cyanide	74-90-8					4.7E+01		4.7E+01	2.3E+01
				2.0E-03	I					1			1.4E+09		~Potassium Cyanide	151-50-8					1.6E+02			1.6E+02
				5.0E-03	I					0.04			1.4E+09		~Potassium Silver Cyanide	506-61-6					3.9E+02			3.9E+02
				1.0E-01	I					0.04			1.4E+09		~Silver Cyanide	506-64-9					7.8E+03			7.8E+03
				1.0E-03	I					1			1.4E+09		~Sodium Cyanide	143-33-9					7.8E+01			7.8E+01
				2.0E-04	P					1			1.4E+09		~Thiocyanates	NA					1.6E+01			1.6E+01
				2.0E-04	X					1			1.4E+09		~Thiocyanic Acid	463-56-9								
				5.0E-02	I					1			1.4E+09		~Zinc Cyanide	557-21-1					3.9E+03			3.9E+03
						6.0E+00	I	V		1		1.2E+02	1.4E+09	1.1E+03	Cyclohexane	110-82-7							7.0E+03	7.0E+03
2.3E-02	H									1	0.1		1.4E+09		Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.8E+01	8.8E+01		2.1E+01				
				5.0E+00	I	7.0E-01	P			1	0.1		1.4E+09		Cyclohexanone	108-94-1					3.9E+05	1.4E+06	9.9E+08	3.1E+05
				5.0E-03	P	1.0E+00	X	V		1		2.8E+02	1.4E+09	1.4E+03	Cyclohexene	110-83-8					3.9E+02		1.5E+03	3.1E+02
				2.0E-01	I					1	0.1		1.4E+09		Cyclohexylamine	108-91-8					1.6E+04	5.6E+04		1.2E+04
				5.0E-03	I					1	0.1		1.4E+09		Cyhalothrin/karate	68085-85-8					3.9E+02	1.4E+03		3.1E+02
				1.0E-02	I					1	0.1		1.4E+09		Cypermethrin	52315-07-8					7.8E+02	2.8E+03		6.1E+02
				7.5E-03	I					1	0.1		1.4E+09		Cyromazine	66215-27-8					5.9E+02	2.1E+03		4.6E+02
2.4E-01	I	6.9E-05	C							1	0.1		1.4E+09		DDD	72-54-8	2.7E+00	8.4E+00	4.8E+04	2.0E+00				
3.4E-01	I	9.7E-05	C							1	0.1		1.4E+09		DDE, p,p'-	72-55-9	1.9E+00	5.9E+00	3.4E+04	1.4E+00				
3.4E-01	I	9.7E-05	I	5.0E-04	I					1	0.03		1.4E+09		DDT	50-29-3	1.9E+00	2.0E+01	3.4E+04	1.7E+00	3.9E+01	4.7E+02		3.6E+01

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Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.0E-02	I					1	0.1		1.4E+09		Dacthal	1861-32-1					7.8E+02	2.8E+03		6.1E+02
				3.0E-02	I					1	0.1		1.4E+09		Dalapon	75-99-0					2.3E+03	8.4E+03		1.8E+03
7.0E-04	I			7.0E-03	I					1	0.1		1.4E+09		Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	9.1E+02	2.9E+03		6.9E+02	5.5E+02	2.0E+03		4.3E+02
				4.0E-05	I					1	0.1		1.4E+09		Demeton	8065-48-3					3.1E+00	1.1E+01		2.4E+00
1.2E-03	I			6.0E-01	I					1	0.1		1.4E+09		Di(2-ethylhexyl)adipate	103-23-1	5.3E+02	1.7E+03		4.1E+02	4.7E+04	1.7E+05		3.7E+04
6.1E-02	H									1	0.1		1.4E+09		Diallate	2303-16-4	1.0E+01	3.3E+01		8.0E+00				
				7.0E-04	A					1	0.1		1.4E+09		Diazinon	333-41-5					5.5E+01	2.0E+02		4.3E+01
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	1		9.8E+02	1.4E+09	3.4E+04	Dibromo-3-chloropropane, 1,2-	96-12-8	1.9E-01		5.5E-03	5.4E-03	1.6E+01		7.2E+00	4.9E+00
				1.0E-02	I					1	0.1		1.4E+09		Dibromobenzene, 1,4-	106-37-6					7.8E+02	2.8E+03		6.1E+02
8.4E-02	I	2.7E-05	C	2.0E-02	I			V		1	0.1	8.0E+02	1.4E+09	8.6E+03	Dibromochloromethane	124-48-1	7.6E+00	2.4E+01	7.7E-01	6.8E-01	1.6E+03	5.6E+03		1.2E+03
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1		1.3E+03	1.4E+09	9.3E+03	Dibromoethane, 1,2-	106-93-4	3.2E-01		3.8E-02	3.4E-02	7.0E+02		8.7E+01	7.8E+01
				1.0E-02	H	4.0E-03	X	V		1		2.8E+03	1.4E+09	6.1E+03	Dibromomethane (Methylene Bromide)	74-95-3					7.8E+02		2.5E+01	2.5E+01
				1.0E-01	I					1	0.1		1.4E+09		Dibutyl Phthalate	84-74-2					7.8E+03	2.8E+04		6.1E+03
				3.0E-04	P					1	0.1		1.4E+09		Dibutyltin Compounds	NA					2.3E+01	8.4E+01		1.8E+01
				3.0E-02	I					1	0.1		1.4E+09		Dicamba	1918-00-9					2.3E+03	8.4E+03		1.8E+03
		4.2E-03	P					V		1		5.2E+02	1.4E+09	1.2E+04	Dichloro-2-butene, 1,4-	764-41-0			6.9E-03	6.9E-03				
		4.2E-03	P					V		1	0.1	5.2E+02	1.4E+09	1.2E+04	Dichloro-2-butene, cis-1,4-	1476-11-5			6.9E-03	6.9E-03				
		4.2E-03	P					V		1	0.1	7.6E+02	1.4E+09	1.2E+04	Dichloro-2-butene, trans-1,4-	110-57-6			6.9E-03	6.9E-03				
5.0E-02	I			4.0E-03	I					1	0.1		1.4E+09		Dichloroacetic Acid	79-43-6	1.3E+01	4.0E+01		9.7E+00	3.1E+02	1.1E+03		2.4E+02
				9.0E-02	I	2.0E-01	H	V		1		3.8E+02	1.4E+09	1.3E+04	Dichlorobenzene, 1,2-	95-50-1					7.0E+03		2.6E+03	1.9E+03
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		1			1.4E+09	1.1E+04	Dichlorobenzene, 1,4-	106-46-7	1.2E+02		2.5E+00	2.4E+00	5.5E+03		9.4E+03	3.5E+03
4.5E-01	I	3.4E-04	C							1	0.1		1.4E+09		Dichlorobenzidine, 3,3'-	91-94-1	1.4E+00	4.5E+00	9.7E+03	1.1E+00				
				9.0E-03	X					1	0.1		1.4E+09		Dichlorobenzophenone, 4,4'-	90-98-2					7.0E+02	2.5E+03		5.5E+02
				2.0E-01	I	1.0E-01	X	V		1		8.5E+02	1.4E+09	9.1E+02	Dichlorodifluoromethane	75-71-8					1.6E+04		9.4E+01	9.4E+01
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1		1.7E+03	1.4E+09	2.2E+03	Dichloroethane, 1,1-	75-34-3	1.1E+02		3.4E+00	3.3E+00	1.6E+04			1.6E+04
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		1		3.0E+03	1.4E+09	4.9E+03	Dichloroethane, 1,2-	107-06-2	7.0E+00		4.6E-01	4.3E-01	4.7E+02		3.6E+01	3.3E+01
				5.0E-02	I	2.0E-01	I	V		1		1.2E+03	1.4E+09	1.2E+03	Dichloroethylene, 1,1-	75-35-4					3.9E+03		2.6E+02	2.4E+02
				9.0E-03	H			V		1		1.3E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0					7.0E+02			7.0E+02
				2.0E-03	I			V		1		2.4E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2-cis-	156-59-2					1.6E+02			1.6E+02
				2.0E-02	I	6.0E-02	P	V		1		1.7E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2-trans-	156-60-5					1.6E+03		1.7E+02	1.5E+02
				3.0E-03	I					1	0.1		1.4E+09		Dichlorophenol, 2,4-	120-83-2					2.3E+02	8.4E+02		1.8E+02
				1.0E-02	I					1	0.05		1.4E+09		Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					7.8E+02	5.6E+03		6.9E+02
				8.0E-03	I					1	0.1		1.4E+09		Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6					6.3E+02	2.2E+03		4.9E+02
3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		1		1.4E+03	1.4E+09	4.1E+03	Dichloropropane, 1,2-	78-87-5	1.8E+01		9.9E-01	9.4E-01	7.0E+03		1.7E+01	1.7E+01
				2.0E-02	P			V		1		1.5E+03	1.4E+09	7.3E+03	Dichloropropane, 1,3-	142-28-9					1.6E+03			1.6E+03
				3.0E-03	I					1	0.1		1.4E+09		Dichloropropanol, 2,3-	616-23-9					2.3E+02	8.4E+02		1.8E+02
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1		1.6E+03	1.4E+09	3.8E+03	Dichloropropene, 1,3-	542-75-6	6.4E+00		2.3E+00	1.7E+00	2.3E+03		8.0E+01	7.7E+01
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1	0.1		1.4E+09		Dichlorvos	62-73-7	2.2E+00	7.0E+00	4.0E+04	1.7E+00	3.9E+01	1.4E+02	7.1E+05	3.1E+01
				8.0E-03	P	7.0E-03	P	V		1			1.4E+09	4.4E+03	Dicyclopentadiene	77-73-6					6.3E+02		3.2E+01	3.1E+01
1.6E+01	I	4.6E-03	I	5.0E-05	I					1	0.1		1.4E+09		Dieldrin	60-57-1	4.0E-02	1.3E-01	7.2E+02	3.0E-02	3.9E+00	1.4E+01		3.1E+00
		3.0E-04	C			5.0E-03	I			1	0.1				Diesel Engine Exhaust	NA								
				2.0E-03	P	2.0E-04	P			1	0.1		1.4E+09		Diethanolamine	111-42-2					1.6E+02	5.6E+02	2.8E+05	1.2E+02
				8.0E-01	I					1	0.1		1.4E+09		Diethyl Phthalate	84-66-2					6.3E+04	2.2E+05		4.9E+04
				3.0E-02	P	1.0E-04	P			1	0.1		1.4E+09		Diethylene Glycol Monobutyl Ether	112-34-5					2.3E+03	8.4E+03	1.4E+05	1.8E+03
				6.0E-02	P	3.0E-04	P			1	0.1		1.4E+09		Diethylene Glycol Monoethyl Ether	111-90-0					4.7E+03	1.7E+04	4.3E+05	3.6E+03
				1.0E-03	P					1	0.1		1.4E+09		Diethylformamide	617-84-5					7.8E+01	2.8E+02		6.1E+01
3.5E+02	C	1.0E-01	C							1	0.1		1.4E+09		Diethylstilbestrol	56-53-1	1.8E-03	5.8E-03	3.3E+01	1.4E-03				
				8.0E-02	I					1	0.1		1.4E+09		Difenzoquat	43222-48-6					6.3E+03	2.2E+04		4.9E+03
				2.0E-02	I					1	0.1		1.4E+09		Diflubenzuron	35367-38-5					1.6E+03	5.6E+03		1.2E+03
						4.0E+01	I	V		1		1.4E+03	1.4E+09	1.2E+03	Difluoroethane, 1,1-	75-37-6							5.2E+04	5.2E+04
4.4E-02	C	1.3E-05	C					V		1	0.1		1.4E+09	1.3E+03	Dihydrosafrole	94-58-6	1.5E+01	4.6E+01	2.5E-01	2.4E-01				
						7.0E-01	P	V		1		2.3E+03	1.4E+09	3.3E+03	Diisopropyl Ether	108-20-3							2.4E+03	2.4E+03
				8.0E-02	I			V		1		5.3E+02	1.4E+09	3.1E+04	Diisopropyl Methylphosphonate	1445-75-6					6.3E+03			6.3E+03
				2.0E-02	I					1	0.1		1.4E+09		Dimethipin	55290-64-7					1.6E+03	5.6E+03		1.2E+03
				2.0E-04	I					1	0.1		1.4E+09		Dimethoate	60-51-5					1.6E+01	5.6E+01		1.2E+01
1.4E-02	H									1	0.1		1.4E+09		Dimethoxybenzidine, 3,3'-	119-90-4	4.6E+01	1.4E+02		3.5E+01				
1.7E-03	P			6.0E-02	P					1	0.1		1.4E+09		Dimethyl methylphosphonate	756-79-6	3.8E+02	1.2E+03		2.9E+02	4.7E+03	1.7E+04		3.7E+03
4.6E+00	C	1.3E-03	C							1	0.1		1.4E+09		Dimethylamino azobenzene [p-]	60-11-7	1.4E-01	4.4E-01	2.5E+03	1.1E-01				
5.8E-01	H									1	0.1		1.4E+09		Dimethylaniline HCl, 2,4-	21436-96-4	1.1E+00	3.5E+00		8.4E-01				
2.0E-01	P			2.0E-03	X					1	0.1		1.4E+09		Dimethylaniline, 2,4-	95-68-1	3.2E+00	1.0E+01		2.4E+00	1.6E+02	5.6E+02		1.2E+02
				2.0E-03	I			V		1		8.3E+02	1.4E+09	3.4E+04	Dimethylaniline, N,N-	121-69-7					1.6E+02			1.6E+02
1.1E+01	P									1	0.1		1.4E+09		Dimethylbenzidine, 3,3'-	119-93-7	5.8E-02	1.8E-01		4.4E-02				
				1.0E-01	P	3.0E-02	I			1	0.1		1.4E+09		Dimethylformamide	68-12-2					7.8E+03	2.8E+04	4.3E+07	6.1E+03
				1.0E-04	X	2.0E-06	X			1	0.1		1.4E+09		Dimethylhydrazine, 1,1-	57-14-7					7.8E+00	2.8E+01	2.8E+03	6.1E+00
5.5E+02	C	1.6E-01	C							1	0.1		1.4E+09		Dimethylhydrazine, 1,2-	540-73-8	1.2E-03	3.7E-03	2.1E+01	8.8E-04				

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-02	I					1	0.1		1.4E+09		Dimethylphenol, 2,4-	105-67-9					1.6E+03	5.6E+03		1.2E+03
				6.0E-04	I					1	0.1		1.4E+09		Dimethylphenol, 2,6-	576-26-1					4.7E+01	1.7E+02		3.7E+01
				1.0E-03	I					1	0.1		1.4E+09		Dimethylphenol, 3,4-	95-65-8					7.8E+01	2.8E+02		6.1E+01
				1.0E-01	I			V		1			1.4E+09	2.3E+04	Dimethylterephthalate	120-61-6					7.8E+03			7.8E+03
4.5E-02	C	1.3E-05	C					V		1	0.1	1.1E+03	1.4E+09	1.1E+03	Dimethylvinylchloride	513-37-1	1.4E+01	4.5E+01	2.0E-01	2.0E-01				
				8.0E-05	X					1	0.1		1.4E+09		Dinitro-o-cresol, 4,6-	534-52-1					6.3E+00	2.2E+01		4.9E+00
				2.0E-03	I					1	0.1		1.4E+09		Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					1.6E+02	5.6E+02		1.2E+02
				1.0E-04	P					1	0.1		1.4E+09		Dinitrobenzene, 1,2-	528-29-0					7.8E+00	2.8E+01		6.1E+00
				1.0E-04	I					1	0.1		1.4E+09		Dinitrobenzene, 1,3-	99-65-0					7.8E+00	2.8E+01		6.1E+00
				1.0E-04	P					1	0.1		1.4E+09		Dinitrobenzene, 1,4-	100-25-4					7.8E+00	2.8E+01		6.1E+00
				2.0E-03	I					1	0.1		1.4E+09		Dinitrophenol, 2,4-	51-28-5					1.6E+02	5.6E+02		1.2E+02
6.8E-01	I									1	0.1		1.4E+09		Dinitrotoluene Mixture, 2,4/2,6-	NA	9.4E-01	3.0E+00		7.2E-01				
3.1E-01	C	8.9E-05	C	2.0E-03	I					1	0.102		1.4E+09		Dinitrotoluene, 2,4-	121-14-2	2.1E+00	6.4E+00	3.7E+04	1.6E+00	1.6E+02	5.5E+02		1.2E+02
1.5E+00	P			3.0E-04	X					1	0.099		1.4E+09		Dinitrotoluene, 2,6-	606-20-2	4.3E-01	1.4E+00		3.3E-01	2.3E+01	8.5E+01		1.8E+01
				2.0E-03	S					1	0.006		1.4E+09		Dinitrotoluene, 2-Amino-4,6-	35572-78-2					1.6E+02	9.3E+03		1.5E+02
				2.0E-03	S					1	0.009		1.4E+09		Dinitrotoluene, 4-Amino-2,6-	19406-51-0					1.6E+02	6.2E+03		1.5E+02
4.5E-01	X			9.0E-04	X					1	0.1		1.4E+09		Dinitrotoluene, Technical grade	25321-14-6	1.4E+00	4.5E+00		1.1E+00	7.0E+01	2.5E+02		5.5E+01
				1.0E-03	I					1	0.1		1.4E+09		Dinoseb	88-85-7					7.8E+01	2.8E+02		6.1E+01
1.0E-01	I	7.7E-06	C	3.0E-02	I	1.1E-01	A			1	0.1		1.4E+09		Dioxane, 1,4-	123-91-1	6.4E+00	2.0E+01	4.3E+05	4.9E+00	2.3E+03	8.4E+03	1.6E+08	1.8E+03
															Dioxins									
6.2E+03	I	1.3E+00	I							1	0.03		1.4E+09		~Hexachlorodibenzo-p-dioxin, Mixture	NA	1.0E-04	1.1E-03	2.5E+00	9.4E-05				
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C			1	0.03		1.4E+09		~TCDD, 2,3,7,8-	1746-01-6	4.9E-06	5.2E-05	8.7E-02	4.5E-06	5.5E-05	6.5E-04	5.7E+01	5.1E-05
				3.0E-02	I					1	0.1		1.4E+09		Diphenamid	957-51-7					2.3E+03	8.4E+03		1.8E+03
				8.0E-04	X					1	0.1		1.4E+09		Diphenyl Sulfone	127-63-9					6.3E+01	2.2E+02		4.9E+01
				2.5E-02	I					1	0.1		1.4E+09		Diphenylamine	122-39-4					2.0E+03	7.0E+03		1.5E+03
8.0E-01	I	2.2E-04	I							1	0.1		1.4E+09		Diphenylhydrazine, 1,2-	122-66-7	8.0E-01	2.5E+00	1.5E+04	6.1E-01				
				2.2E-03	I					1	0.1		1.4E+09		Diquat	85-00-7					1.7E+02	6.1E+02		1.3E+02
7.4E+00	C	2.1E-03	C							1	0.1		1.4E+09		Direct Black 38	1937-37-7	8.7E-02	2.7E-01	1.6E+03	6.6E-02				
7.4E+00	C	2.1E-03	C							1	0.1		1.4E+09		Direct Blue 6	2602-46-2	8.7E-02	2.7E-01	1.6E+03	6.6E-02				
6.7E+00	C	1.9E-03	C							1	0.1		1.4E+09		Direct Brown 95	16071-86-6	9.6E-02	3.0E-01	1.7E+03	7.3E-02				
				4.0E-05	I					1	0.1		1.4E+09		Disulfoton	298-04-4					3.1E+00	1.1E+01		2.4E+00
				1.0E-02	I			V		1	0.1		1.4E+09	4.6E+04	Dithiane, 1,4-	505-29-3					7.8E+02	2.8E+03		6.1E+02
				2.0E-03	I					1	0.1		1.4E+09		Diuron	330-54-1					1.6E+02	5.6E+02		1.2E+02
				4.0E-03	I					1	0.1		1.4E+09		Dodine	2439-10-3					3.1E+02	1.1E+03		2.4E+02
				2.5E-02	I			V		1			1.4E+09	1.3E+05	EPTC	759-94-4					2.0E+03			2.0E+03
				6.0E-03	I					1	0.1		1.4E+09		Endosulfan	115-29-7					4.7E+02	1.7E+03		3.7E+02
				2.0E-02	I					1	0.1		1.4E+09		Endothall	145-73-3					1.6E+03	5.6E+03		1.2E+03
				3.0E-04	I					1	0.1		1.4E+09		Endrin	72-20-8					2.3E+01	8.4E+01		1.8E+01
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1		1.1E+04	1.4E+09	2.0E+04	Epichlorohydrin	106-89-8	6.5E+01		4.1E+01	2.5E+01	4.7E+02		2.1E+01	2.0E+01
						2.0E-02	I	V		1		1.5E+04	1.4E+09	8.2E+03	Epoxybutane, 1,2-	106-88-7							1.7E+02	1.7E+02
				5.0E-03	I					1	0.1		1.4E+09		Ethephon	16672-87-0					3.9E+02	1.4E+03		3.1E+02
				5.0E-04	I					1	0.1		1.4E+09		Ethion	563-12-2					3.9E+01	1.4E+02		3.1E+01
				1.0E-01	P	6.0E-02	P			1	0.1		1.4E+09		Ethoxyethanol Acetate, 2-	111-15-9					7.8E+03	2.8E+04	8.5E+07	6.1E+03
				4.0E-01	H	2.0E-01	I			1	0.1		1.4E+09		Ethoxyethanol, 2-	110-80-5					3.1E+04	1.1E+05	2.8E+08	2.4E+04
				9.0E-01	I			V		1		1.1E+04	1.4E+09	9.3E+03	Ethyl Acetate	141-78-6					7.0E+04			7.0E+04
4.8E-02	H							V		1		2.5E+03	1.4E+09	6.8E+03	Ethyl Acrylate	140-88-5	1.3E+01			1.3E+01				
						1.0E+01	I	V		1		2.1E+03	1.4E+09	1.4E+03	Ethyl Chloride	75-00-3							1.5E+04	1.5E+04
				2.0E-01	I			V		1		1.0E+04	1.4E+09	3.4E+03	Ethyl Ether	60-29-7					1.6E+04			1.6E+04
				9.0E-02	H	3.0E-01	P	V		1		1.1E+03	1.4E+09	6.2E+03	Ethyl Methacrylate	97-63-2					7.0E+03		1.9E+03	1.5E+03
				1.0E-05	I					1	0.1		1.4E+09		Ethyl-p-nitrophenyl Phosphonate	2104-64-5					7.8E-01	2.8E+00		6.1E-01
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		1		4.8E+02	1.4E+09	6.1E+03	Ethylbenzene	100-41-4	5.8E+01		5.9E+00	5.4E+00	7.8E+03		6.4E+03	3.5E+03
				7.0E-02	P					1	0.1		1.4E+09		Ethylene Cyanohydrin	109-78-4					5.5E+03	2.0E+04		4.3E+03
				9.0E-02	P					1	0.1		1.4E+09		Ethylene Diamine	107-15-3					7.0E+03	2.5E+04		5.5E+03
				2.0E+00	I	4.0E-01	C			1	0.1		1.4E+09		Ethylene Glycol	107-21-1					1.6E+05	5.6E+05	5.7E+08	1.2E+05
				1.0E-01	I	1.6E+00	I			1	0.1		1.4E+09		Ethylene Glycol Monobutyl Ether	111-76-2					7.8E+03	2.8E+04	2.3E+09	6.1E+03
3.1E-01	C	8.8E-05	C			3.0E-02	C	V		1		1.2E+05	1.4E+09	6.6E+03	Ethylene Oxide	75-21-8	2.1E+00		1.8E-01	1.7E-01			2.0E+02	2.0E+02
4.5E-02	C	1.3E-05	C	8.0E-05	I					1	0.1		1.4E+09		Ethylene Thiourea	96-45-7	1.4E+01	4.5E+01	2.5E+05	1.1E+01	6.3E+00	2.2E+01		4.9E+00
6.5E+01	C	1.9E-02	C					V		1	0.1	1.5E+05	1.4E+09	2.6E+04	Ethyleneimine	151-56-4	9.9E-03	3.1E-02	3.3E-03	2.3E-03				
				3.0E+00	I					1	0.1		1.4E+09		Ethylphthalyl Ethyl Glycolate	84-72-0					2.3E+05	8.4E+05		1.8E+05
				8.0E-03	I					1	0.1		1.4E+09		Express	101200-48-0					6.3E+02	2.2E+03		4.9E+02
				2.5E-04	I					1	0.1		1.4E+09		Fenamiphos	22224-92-6					2.0E+01	7.0E+01		1.5E+01
				2.5E-02	I					1	0.1		1.4E+09		Fenpropathrin	39515-41-8					2.0E+03	7.0E+03		1.5E+03
				1.3E-02	I					1	0.1		1.4E+09		Fluometuron	2164-17-2					1.0E+03	3.6E+03		7.9E+02
				4.0E-02	C	1.3E-02	C			1			1.4E+09		Fluoride	16984-48-8					3.1E+03		1.8E+07	3.1E+03
				6.0E-02	I	1.3E-02	C			1			1.4E+09		Fluorine (Soluble Fluoride)	7782-41-4					4.7E+03		1.8E+07	4.7E+03

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Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				8.0E-02	I					1	0.1		1.4E+09		Fluridone	59756-60-4					6.3E+03	2.2E+04		4.9E+03
				2.0E-02	I					1	0.1		1.4E+09		Flurprimidol	56425-91-3					1.6E+03	5.6E+03		1.2E+03
				6.0E-02	I					1	0.1		1.4E+09		Flutolanil	66332-96-5					4.7E+03	1.7E+04		3.7E+03
				1.0E-02	I					1	0.1		1.4E+09		Fluvalinate	69409-94-5					7.8E+02	2.8E+03		6.1E+02
3.5E-03	I			1.0E-01	I					1	0.1		1.4E+09		Folpet	133-07-3	1.8E+02	5.8E+02		1.4E+02	7.8E+03	2.8E+04		6.1E+03
1.9E-01	I									1	0.1		1.4E+09		Fomesafen	72178-02-0	3.4E+00	1.1E+01		2.6E+00				
				2.0E-03	I					1	0.1		1.4E+09		Fonofos	944-22-9					1.6E+02	5.6E+02		1.2E+02
		1.3E-05	I	2.0E-01	I	9.8E-03	A			1	0.1		1.4E+09		Formaldehyde	50-00-0			2.5E+05	2.5E+05	1.6E+04	5.6E+04	1.4E+07	1.2E+04
				9.0E-01	P	3.0E-04	X			1	0.1		1.4E+09		Formic Acid	64-18-6					7.0E+04	2.5E+05	4.3E+05	4.9E+04
				3.0E+00	I					1	0.1		1.4E+09		Fosetyl-AL	39148-24-8					2.3E+05	8.4E+05		1.8E+05
															Furans									
				1.0E-03	X			V		1			1.4E+09	2.1E+05	~Dibenzofuran	132-64-9					7.8E+01			7.8E+01
				1.0E-03	I			V		1		6.2E+03	1.4E+09	2.8E+03	~Furan	110-00-9					7.8E+01			7.8E+01
				9.0E-01	I	2.0E+00	I	V		1	0.1	1.7E+05	1.4E+09	1.3E+04	~Tetrahydrofuran	109-99-9					7.0E+04	2.5E+05	2.7E+04	1.8E+04
3.8E+00	H									1	0.1		1.4E+09		Furazolidone	67-45-8	1.7E-01	5.3E-01		1.3E-01				
				3.0E-03	I	5.0E-02	H			1	0.1		1.4E+09		Furfural	98-01-1					2.3E+02	8.4E+02	7.1E+07	1.8E+02
1.5E+00	C	4.3E-04	C							1	0.1		1.4E+09		Furium	531-82-8	4.3E-01	1.3E+00	7.7E+03	3.2E-01				
3.0E-02	I	8.6E-06	C							1	0.1		1.4E+09		Furmecyclox	60568-05-0	2.1E+01	6.7E+01	3.8E+05	1.6E+01				
				4.0E-04	I					1	0.1		1.4E+09		Glufosinate, Ammonium	77182-82-2					3.1E+01	1.1E+02		2.4E+01
						8.0E-05	C			1	0.1		1.4E+09		Glutaraldehyde	111-30-8							1.1E+05	1.1E+05
				4.0E-04	I	1.0E-03	H			1	0.1		1.4E+09		Glycidyl	765-34-4					3.1E+01	1.1E+02	1.4E+06	2.4E+01
				1.0E-01	I					1	0.1		1.4E+09		Glyphosate	1071-83-6					7.8E+03	2.8E+04		6.1E+03
				3.0E-03	I					1	0.1		1.4E+09		Goal	42874-03-3					2.3E+02	8.4E+02		1.8E+02
				3.0E-03	A	1.0E-02	A			1	0.1		1.4E+09		Guthion	86-50-0					2.3E+02	8.4E+02	1.4E+07	1.8E+02
				5.0E-05	I					1	0.1		1.4E+09		Haloxyfop, Methyl	69806-40-2					3.9E+00	1.4E+01		3.1E+00
				1.3E-02	I					1	0.1		1.4E+09		Harmony	79277-27-3					1.0E+03	3.6E+03		7.9E+02
4.5E+00	I	1.3E-03	I	5.0E-04	I					1	0.1		1.4E+09		Heptachlor	76-44-8	1.4E-01	4.5E-01	2.5E+03	1.1E-01	3.9E+01	1.4E+02		3.1E+01
9.1E+00	I	2.6E-03	I	1.3E-05	I					1	0.1		1.4E+09		Heptachlor Epoxide	1024-57-3	7.0E-02	2.2E-01	1.3E+03	5.3E-02	1.0E+00	3.6E+00		7.9E-01
				2.0E-03	I					1	0.1		1.4E+09		Hexabromobenzene	87-82-1					1.6E+02	5.6E+02		1.2E+02
				2.0E-04	I					1	0.1		1.4E+09		Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					1.6E+01	5.6E+01		1.2E+01
1.6E+00	I	4.6E-04	I	8.0E-04	I					1	0.1		1.4E+09		Hexachlorobenzene	118-74-1	4.0E-01	1.3E+00	7.2E+03	3.0E-01	6.3E+01	2.2E+02		4.9E+01
7.8E-02	I	2.2E-05	I	1.0E-03	P					1	0.1		1.4E+09		Hexachlorobutadiene	87-68-3	8.2E+00	2.6E+01	1.5E+05	6.2E+00	7.8E+01	2.8E+02		6.1E+01
6.3E+00	I	1.8E-03	I	8.0E-03	A					1	0.1		1.4E+09		Hexachlorocyclohexane, Alpha-	319-84-6	1.0E-01	3.2E-01	1.8E+03	7.7E-02	6.3E+02	2.2E+03		4.9E+02
1.8E+00	I	5.3E-04	I							1	0.1		1.4E+09		Hexachlorocyclohexane, Beta-	319-85-7	3.6E-01	1.1E+00	6.2E+03	2.7E-01				
1.1E+00	C	3.1E-04	C	3.0E-04	I					1	0.04		1.4E+09		Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	5.8E-01	4.6E+00	1.1E+04	5.2E-01	2.3E+01	2.1E+02		2.1E+01
1.8E+00	I	5.1E-04	I							1	0.1		1.4E+09		Hexachlorocyclohexane, Technical	608-73-1	3.6E-01	1.1E+00	6.5E+03	2.7E-01				
				6.0E-03	I	2.0E-04	I			1	0.1		1.4E+09		Hexachlorocyclopentadiene	77-47-4					4.7E+02	1.7E+03	2.8E+05	3.7E+02
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I			1	0.1		1.4E+09		Hexachloroethane	67-72-1	1.6E+01	5.1E+01	3.0E+05	1.2E+01	5.5E+01	2.0E+02	4.3E+07	4.3E+01
				3.0E-04	I					1	0.1		1.4E+09		Hexachlorophene	70-30-4					2.3E+01	8.4E+01		1.8E+01
1.1E-01	I			3.0E-03	I					1	0.015		1.4E+09		Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5.8E+00	1.2E+02		5.6E+00	2.3E+02	5.6E+03		2.3E+02
						1.0E-05	I	V		1		5.2E+03	1.4E+09	3.2E+05	Hexamethylene Diisocyanate, 1,6-	822-06-0							3.4E+00	3.4E+00
				4.0E-04	P					1	0.1		1.4E+09		Hexamethylphosphoramide	680-31-9					3.1E+01	1.1E+02		2.4E+01
				6.0E-02	H	7.0E-01	I	V		1		1.4E+02	1.4E+09	8.9E+02	Hexane, N-	110-54-3					4.7E+03		6.5E+02	5.7E+02
				2.0E+00	P					1	0.1		1.4E+09		Hexanedioic Acid	124-04-9					1.6E+05	5.6E+05		1.2E+05
				5.0E-03	I	3.0E-02	I	V		1		3.3E+03	1.4E+09	1.4E+04	Hexanone, 2-	591-78-6					3.9E+02		4.5E+02	2.1E+02
				3.3E-02	I					1	0.1		1.4E+09		Hexazinone	51235-04-2					2.6E+03	9.2E+03		2.0E+03
3.0E+00	I	4.9E-03	I			3.0E-05	P			1			1.4E+09		Hydrazine	302-01-2	2.1E-01		6.8E+02	2.1E-01			4.3E+04	4.3E+04
3.0E+00	I	4.9E-03	I							1			1.4E+09		Hydrazine Sulfate	10034-93-2	2.1E-01		6.8E+02	2.1E-01				
						2.0E-02	I			1			1.4E+09		Hydrogen Chloride	7647-01-0							2.8E+07	2.8E+07
				4.0E-02	C	1.4E-02	C			1			1.4E+09		Hydrogen Fluoride	7664-39-3					3.1E+03		2.0E+07	3.1E+03
						2.0E-03	I			1			1.4E+09		Hydrogen Sulfide	7783-06-4							2.8E+06	2.8E+06
6.0E-02	P			4.0E-02	P					1	0.1		1.4E+09		Hydroquinone	123-31-9	1.1E+01	3.4E+01		8.1E+00	3.1E+03	1.1E+04		2.4E+03
				1.3E-02	I					1	0.1		1.4E+09		Imazalil	35554-44-0					1.0E+03	3.6E+03		7.9E+02
				2.5E-01	I					1	0.1		1.4E+09		Imazaquin	81335-37-7					2.0E+04	7.0E+04		1.5E+04
				1.0E-02	A					1			1.4E+09		Iodine	7553-56-2					7.8E+02			7.8E+02
				4.0E-02	I					1	0.1		1.4E+09		Iprodione	36734-19-7					3.1E+03	1.1E+04		2.4E+03
				7.0E-01	P					1			1.4E+09		Iron	7439-89-6					5.5E+04			5.5E+04
				3.0E-01	I					1	0.1		1.4E+09		Isobutyl Alcohol	78-83-1					2.3E+04	8.4E+04		1.8E+04
9.5E-04	I			2.0E-01	I	2.0E+00	C			1	0.1		1.4E+09		Isophorone	78-59-1	6.7E+02	2.1E+03		5.1E+02	1.6E+04	5.6E+04	2.8E+09	1.2E+04
				1.5E-02	I					1	0.1		1.4E+09		Isopropalin	33820-53-0					1.2E+03	4.2E+03		9.2E+02
						7.0E+00	C			1	0.1		1.4E+09		Isopropanol	67-63-0							9.9E+09	9.9E+09
				1.0E-01	I					1	0.1		1.4E+09		Isopropyl Methyl Phosphonic Acid	1832-54-8					7.8E+03	2.8E+04		6.1E+03
				5.0E-02	I					1	0.1		1.4E+09		Isoxaben	82558-50-7					3.9E+03	1.4E+04		3.1E+03
						3.0E-01	A	V		1			1.4E+09		JP-7	NA							4.3E+08	4.3E+08
				7.5E-02	I					1	0.1		1.4E+09		Kerb	23950-58-5					5.9E+03	2.1E+04		4.6E+03

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-03	I					1	0.1		1.4E+09		Lactofen	77501-63-4					1.6E+02	5.6E+02		1.2E+02
															Lead Compounds									
2.8E-01	C	8.0E-05	C							1	0.1		1.4E+09		~Lead acetate	301-04-2	2.3E+00	7.2E+00	4.1E+04	1.7E+00				
										1			1.4E+09		~Lead and Compounds	7439-92-1								4.0E+02
3.8E-02	C	1.1E-05	C							1	0.1		1.4E+09		~Lead subacetate	1335-32-6	1.7E+01	5.3E+01	3.0E+05	1.3E+01				
				1.0E-07	I					1	0.1		1.4E+09		~Tetraethyl Lead	78-00-2					7.8E-03	2.8E-02		6.1E-03
				2.0E-03	I					1	0.1		1.4E+09		Linuron	330-55-2					1.6E+02	5.6E+02		1.2E+02
				2.0E-03	P					1			1.4E+09		Lithium	7439-93-2					1.6E+02			1.6E+02
				2.0E-01	I					1	0.1		1.4E+09		Londax	83055-99-6					1.6E+04	5.6E+04		1.2E+04
				5.0E-04	I					1	0.1		1.4E+09		MCPA	94-74-6					3.9E+01	1.4E+02		3.1E+01
				1.0E-02	I					1	0.1		1.4E+09		MCPB	94-81-5					7.8E+02	2.8E+03		6.1E+02
				1.0E-03	I					1	0.1		1.4E+09		MCPP	93-65-2					7.8E+01	2.8E+02		6.1E+01
				2.0E-02	I					1	0.1		1.4E+09		Malathion	121-75-5					1.6E+03	5.6E+03		1.2E+03
				1.0E-01	I	7.0E-04	C			1	0.1		1.4E+09		Maleic Anhydride	108-31-6					7.8E+03	2.8E+04	9.9E+05	6.1E+03
				5.0E-01	I					1	0.1		1.4E+09		Maleic Hydrazide	123-33-1					3.9E+04	1.4E+05		3.1E+04
				1.0E-04	P					1	0.1		1.4E+09		Malononitrile	109-77-3					7.8E+00	2.8E+01		6.1E+00
				3.0E-02	H					1	0.1		1.4E+09		Mancozeb	8018-01-7					2.3E+03	8.4E+03		1.8E+03
				5.0E-03	I					1	0.1		1.4E+09		Maneb	12427-38-2					3.9E+02	1.4E+03		3.1E+02
				1.4E-01	I	5.0E-05	I			1					Manganese (Diet)	7439-96-5								
				2.4E-02	S	5.0E-05	I			0.04			1.4E+09		Manganese (Non-diet)	7439-96-5					1.9E+03		7.1E+04	1.8E+03
				9.0E-05	H					1	0.1		1.4E+09		Mephosfolan	950-10-7					7.0E+00	2.5E+01		5.5E+00
				3.0E-02	I					1	0.1		1.4E+09		Mepiquat Chloride	24307-26-4					2.3E+03	8.4E+03		1.8E+03
															Mercury Compounds									
				3.0E-04	I	3.0E-04	S			0.07			1.4E+09		~Mercuric Chloride (and other Mercury salts)	7487-94-7					2.3E+01		4.3E+05	2.3E+01
						3.0E-04	I	V		1		3.1E+00	1.4E+09	3.2E+04	~Mercury (elemental)	7439-97-6							1.0E+01	1.0E+01
				1.0E-04	I					1			1.4E+09		~Methyl Mercury	22967-92-6					7.8E+00			7.8E+00
				8.0E-05	I					1	0.1		1.4E+09		~Phenylmercuric Acetate	62-38-4					6.3E+00	2.2E+01		4.9E+00
				3.0E-05	I					1	0.1		1.4E+09		Merphos	150-50-5					2.3E+00	8.4E+00		1.8E+00
				3.0E-05	I					1	0.1		1.4E+09		Merphos Oxide	78-48-8					2.3E+00	8.4E+00		1.8E+00
				6.0E-02	I					1	0.1		1.4E+09		Metalaxyl	57837-19-1					4.7E+03	1.7E+04		3.7E+03
				1.0E-04	I	3.0E-02	P	V		1		4.6E+03	1.4E+09	7.3E+03	Methacrylonitrile	126-98-7					7.8E+00		2.3E+02	7.6E+00
				5.0E-05	I					1	0.1		1.4E+09		Methamidophos	10265-92-6					3.9E+00	1.4E+01		3.1E+00
				5.0E-01	I	4.0E+00	C			1	0.1		1.4E+09		Methanol	67-56-1					3.9E+04	1.4E+05	5.7E+09	3.1E+04
				1.0E-03	I					1	0.1		1.4E+09		Methidathion	950-37-8					7.8E+01	2.8E+02		6.1E+01
				2.5E-02	I					1	0.1		1.4E+09		Methomyl	16752-77-5					2.0E+03	7.0E+03		1.5E+03
4.9E-02	C	1.4E-05	C							1	0.1		1.4E+09		Methoxy-5-nitroaniline, 2-	99-59-2	1.3E+01	4.1E+01	2.4E+05	9.9E+00				
				5.0E-03	I					1	0.1		1.4E+09		Methoxychlor	72-43-5					3.9E+02	1.4E+03		3.1E+02
				8.0E-03	P	1.0E-03	P			1	0.1		1.4E+09		Methoxyethanol Acetate, 2-	110-49-6					6.3E+02	2.2E+03	1.4E+06	4.9E+02
				5.0E-03	P	2.0E-02	I			1	0.1		1.4E+09		Methoxyethanol, 2-	109-86-4					3.9E+02	1.4E+03	2.8E+07	3.1E+02
				1.0E+00	X			V		1		2.9E+04	1.4E+09	8.7E+03	Methyl Acetate	79-20-9					7.8E+04			7.8E+04
				3.0E-02	H	2.0E-02	P	V		1		6.8E+03	1.4E+09	7.5E+03	Methyl Acrylate	96-33-3					2.3E+03		1.6E+02	1.5E+02
				6.0E-01	I	5.0E+00	I	V		1		2.8E+04	1.4E+09	1.3E+04	Methyl Ethyl Ketone (2-Butanone)	78-93-3					4.7E+04		6.8E+04	2.8E+04
		1.0E-03	X	1.0E-03	P	2.0E-05	X			1	0.1		1.4E+09		Methyl Hydrazine	60-34-4			3.3E+03	3.3E+03	7.8E+01	2.8E+02	2.8E+04	6.1E+01
				8.0E-02	H	3.0E+00	I	V		1		3.4E+03	1.4E+09	1.1E+04	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1					6.3E+03		3.6E+04	5.3E+03
						1.0E-03	C	V		1	0.1	1.7E+04	1.4E+09	4.8E+03	Methyl Isocyanate	624-83-9							5.0E+00	5.0E+00
				1.4E+00	I	7.0E-01	I	V		1		2.4E+03	1.4E+09	6.8E+03	Methyl Methacrylate	80-62-6					1.1E+05		5.0E+03	4.8E+03
				2.5E-04	I					1	0.1		1.4E+09		Methyl Parathion	298-00-0					2.0E+01	7.0E+01		1.5E+01
				6.0E-02	X					1	0.1		1.4E+09		Methyl Phosphonic Acid	993-13-5					4.7E+03	1.7E+04		3.7E+03
				6.0E-03	H	4.0E-02	H	V		1		3.9E+02	1.4E+09	1.2E+04	Methyl Styrene (Mixed Isomers)	25013-15-4					4.7E+02		4.8E+02	2.4E+02
9.9E-02	C	2.8E-05	C							1	0.1		1.4E+09		Methyl methanesulfonate	66-27-3	6.5E+00	2.0E+01	1.2E+05	4.9E+00				
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		1		8.9E+03	1.4E+09	5.3E+03	Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.6E+02		4.9E+01	4.3E+01			1.7E+04	1.7E+04
				3.0E-04	X					1	0.1		1.4E+09		Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					2.3E+01	8.4E+01		1.8E+01
9.0E-03	P			2.0E-02	X					1	0.1		1.4E+09		Methyl-5-Nitroaniline, 2-	99-55-8	7.1E+01	2.2E+02		5.4E+01	1.6E+03	5.6E+03		1.2E+03
8.3E+00	C	2.4E-03	C							1	0.1		1.4E+09		Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	7.7E-02	2.4E-01	1.4E+03	5.9E-02				
1.3E-01	C	3.7E-05	C							1	0.1		1.4E+09		Methylaniline Hydrochloride, 2-	636-21-5	4.9E+00	1.6E+01	8.9E+04	3.7E+00				
				1.0E-02	A					1	0.1		1.4E+09		Methylarsonic acid	124-58-3					7.8E+02	2.8E+03		6.1E+02
				2.0E-04	X					1	0.1		1.4E+09		Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					1.6E+01	5.6E+01		1.2E+01
1.0E-01	X			3.0E-04	X					1	0.1		1.4E+09		Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	6.4E+00	2.0E+01		4.9E+00	2.3E+01	8.4E+01		1.8E+01
2.2E+01	C	6.3E-03	C						M	1	0.1		1.4E+09		Methylcholanthrene, 3-	56-49-5	6.8E-03	2.3E-02	2.1E+02	5.2E-03				
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	1		3.3E+03	1.4E+09	2.4E+03	Methylene Chloride	75-09-2	7.5E+01		2.3E+02	5.6E+01	4.7E+02		1.5E+03	3.6E+02
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	1	0.1		1.4E+09		Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.5E+00	5.1E+00	3.0E+03	1.2E+00	1.6E+02	5.6E+02		1.2E+02
4.6E-02	I	1.3E-05	C							1	0.1		1.4E+09		Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.4E+01	4.4E+01	2.5E+05	1.1E+01				
1.6E+00	C	4.6E-04	C			2.0E-02	C			1	0.1		1.4E+09		Methylenebisbenzenamine, 4,4'-	101-77-9	4.0E-01	1.3E+00	7.2E+03	3.0E-01			2.8E+07	2.8E+07
						6.0E-04	I			1	0.1		1.4E+09		Methylenediphenyl Diisocyanate	101-68-8							8.5E+05	8.5E+05
				7.0E-02	H			V		1		5.0E+02	1.4E+09	1.4E+04	Methylstyrene, Alpha-	98-83-9					5.5E+03			5.5E+03

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.5E-01	I					1	0.1		1.4E+09		Metolachlor	51218-45-2					1.2E+04	4.2E+04		9.2E+03
				2.5E-02	I					1	0.1		1.4E+09		Metribuzin	21087-64-9					2.0E+03	7.0E+03		1.5E+03
				3.0E+00	P			V		1	0.1	3.4E-01	1.4E+09	1.1E+03	Mineral oils	8012-95-1					2.3E+05	8.4E+05		1.8E+05
1.8E+01	C	5.1E-03	C	2.0E-04	I					1	0.1		1.4E+09		Mirex	2385-85-5	3.6E-02	1.1E-01	6.5E+02	2.7E-02	1.6E+01	5.6E+01		1.2E+01
				2.0E-03	I					1	0.1		1.4E+09		Molinate	2212-67-1					1.6E+02	5.6E+02		1.2E+02
				5.0E-03	I					1			1.4E+09		Molybdenum	7439-98-7					3.9E+02			3.9E+02
				1.0E-01	I					1			1.4E+09		Monochloramine	10599-90-3					7.8E+03			7.8E+03
				2.0E-03	P					1	0.1		1.4E+09		Monomethylaniline	100-61-8					1.6E+02	5.6E+02		1.2E+02
				3.0E-04	X					1	0.1		1.4E+09		N,N'-Diphenyl-1,4-benzenediamine	74-31-7					2.3E+01	8.4E+01		1.8E+01
				2.0E-03	I					1	0.1		1.4E+09		Naled	300-76-5					1.6E+02	5.6E+02		1.2E+02
				3.0E-02	X	1.0E-01	P	V		1			1.4E+09		Naphtha, High Flash Aromatic (HFAN)	64724-95-6					2.3E+03		1.4E+08	2.3E+03
1.8E+00	C	0.0E+00	C							1	0.1		1.4E+09		Naphthylamine, 2-	91-59-8	3.6E-01	1.1E+00		2.7E-01				
				1.0E-01	I					1	0.1		1.4E+09		Napropamide	15299-99-7					7.8E+03	2.8E+04		6.1E+03
				1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Carbonyl	13463-39-3					8.6E+02		2.0E+04	8.2E+02
				1.1E-02	C	2.0E-05	C			1			1.4E+09		Nickel Oxide	1313-99-1					8.6E+02		2.8E+04	8.4E+02
		2.4E-04	I	1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Refinery Dust	NA			1.4E+04	1.4E+04	8.6E+02		2.0E+04	8.2E+02
		2.6E-04	C	2.0E-02	I	9.0E-05	A			0.04			1.4E+09		Nickel Soluble Salts	7440-02-0			1.3E+04	1.3E+04	1.6E+03		1.3E+05	1.5E+03
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Subsulfide	12035-72-2	3.8E-01		6.9E+03	3.8E-01	8.6E+02		2.0E+04	8.2E+02
				1.6E+00	I					1			1.4E+09		Nitrate	14797-55-8					1.3E+05			1.3E+05
										1			1.4E+09		Nitrate + Nitrite (as N)	NA								
				1.0E-01	I					1			1.4E+09		Nitrite	14797-65-0					7.8E+03			7.8E+03
				1.0E-02	X	5.0E-05	X			1	0.1		1.4E+09		Nitroaniline, 2-	88-74-4					7.8E+02	2.8E+03	7.1E+04	6.1E+02
2.0E-02	P			4.0E-03	P	6.0E-03	P			1	0.1		1.4E+09		Nitroaniline, 4-	100-01-6	3.2E+01	1.0E+02		2.4E+01	3.1E+02	1.1E+03	8.5E+06	2.4E+02
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		1		3.1E+03	1.4E+09	7.9E+04	Nitrobenzene	98-95-3			4.8E+00	4.8E+00	1.6E+02		7.4E+02	1.3E+02
				3.0E+03	P					1	0.1		1.4E+09		Nitrocellulose	9004-70-0					2.3E+08	8.4E+08		1.8E+08
				7.0E-02	H					1	0.1		1.4E+09		Nitrofurantoin	67-20-9					5.5E+03	2.0E+04		4.3E+03
1.3E+00	C	3.7E-04	C							1	0.1		1.4E+09		Nitrofurazone	59-87-0	4.9E-01	1.6E+00	8.9E+03	3.7E-01				
1.7E-02	P			1.0E-04	P					1	0.1		1.4E+09		Nitroglycerin	55-63-0	3.8E+01	1.2E+02		2.9E+01	7.8E+00	2.8E+01		6.1E+00
				1.0E-01	I					1	0.1		1.4E+09		Nitroguanidine	556-88-7					7.8E+03	2.8E+04		6.1E+03
		9.0E-06	P			2.0E-02	P	V		1		1.8E+04	1.4E+09	1.8E+04	Nitromethane	75-52-5			4.9E+00	4.9E+00			3.8E+02	3.8E+02
		2.7E-03	H			2.0E-02	I	V		1		4.9E+03	1.4E+09	1.4E+04	Nitropropane, 2-	79-46-9			1.3E-02	1.3E-02			2.9E+02	2.9E+02
2.7E+01	C	7.7E-03	C						M	1	0.1		1.4E+09		Nitroso-N-ethylurea, N-	759-73-9	5.5E-03	1.9E-02	1.7E+02	4.3E-03				
1.2E+02	C	3.4E-02	C						M	1	0.1		1.4E+09		Nitroso-N-methylurea, N-	684-93-5	1.2E-03	4.2E-03	3.8E+01	9.6E-04				
5.4E+00	I	1.6E-03	I					V		1			1.4E+09	2.1E+05	Nitroso-di-N-butylamine, N-	924-16-3	1.2E-01		3.2E-01	8.7E-02				
7.0E+00	I	2.0E-03	C							1	0.1		1.4E+09		Nitroso-di-N-propylamine, N-	621-64-7	9.1E-02	2.9E-01	1.7E+03	6.9E-02				
2.8E+00	I	8.0E-04	C							1	0.1		1.4E+09		Nitrosodiethanolamine, N-	1116-54-7	2.3E-01	7.2E-01	4.1E+03	1.7E-01				
1.5E+02	I	4.3E-02	I						M	1	0.1		1.4E+09		Nitrosodiethylamine, N-	55-18-5	9.9E-04	3.4E-03	3.0E+01	7.7E-04				
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	1	0.1		1.4E+09		Nitrosodimethylamine, N-	62-75-9	2.9E-03	9.9E-03	9.3E+01	2.3E-03	6.3E-01	2.2E+00	5.7E+04	4.9E-01
4.9E-03	I	2.6E-06	C							1	0.1		1.4E+09		Nitrosodiphenylamine, N-	86-30-6	1.3E+02	4.1E+02	1.3E+06	9.9E+01				
2.2E+01	I	6.3E-03	C							1	0.1		1.4E+09		Nitrosomethylethylamine, N-	10595-95-6	2.9E-02	9.2E-02	5.3E+02	2.2E-02				
6.7E+00	C	1.9E-03	C							1	0.1		1.4E+09		Nitrosomorpholine [N-]	59-89-2	9.6E-02	3.0E-01	1.7E+03	7.3E-02				
9.4E+00	C	2.7E-03	C							1	0.1		1.4E+09		Nitrosopiperidine [N-]	100-75-4	6.8E-02	2.2E-01	1.2E+03	5.2E-02				
2.1E+00	I	6.1E-04	I							1	0.1		1.4E+09		Nitrosopyrrolidine, N-	930-55-2	3.0E-01	9.6E-01	5.4E+03	2.3E-01				
				1.0E-04	X					1	0.1		1.4E+09		Nitrotoluene, m-	99-08-1					7.8E+00	2.8E+01		6.1E+00
2.2E-01	P			9.0E-04	P			V		1		1.5E+03	1.4E+09	1.5E+05	Nitrotoluene, o-	88-72-2	2.9E+00			2.9E+00	7.0E+01			7.0E+01
1.6E-02	P			4.0E-03	P					1	0.1		1.4E+09		Nitrotoluene, p-	99-99-0	4.0E+01	1.3E+02		3.0E+01	3.1E+02	1.1E+03		2.4E+02
				3.0E-04	X	2.0E-01	P	V		1		6.9E+00	1.4E+09	1.1E+03	Nonane, n-	111-84-2					2.3E+01		2.3E+02	2.1E+01
				4.0E-02	I					1	0.1		1.4E+09		Norflurazon	27314-13-2					3.1E+03	1.1E+04		2.4E+03
				7.0E-04	I					1	0.1		1.4E+09		Nustar	85509-19-9					5.5E+01	2.0E+02		4.3E+01
				3.0E-03	I					1	0.1		1.4E+09		Octabromodiphenyl Ether	32536-52-0					2.3E+02	8.4E+02		1.8E+02
				5.0E-02	I					1	0.006		1.4E+09		Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					3.9E+03	2.3E+05		3.8E+03
				2.0E-03	H					1	0.1		1.4E+09		Octamethylpyrophosphoramide	152-16-9					1.6E+02	5.6E+02		1.2E+02
				1.0E-02	P					1	0.1		1.4E+09		Octyl Phthalate, di-N-	117-84-0					7.8E+02	2.8E+03		6.1E+02
				5.0E-02	I					1	0.1		1.4E+09		Oryzalin	19044-88-3					3.9E+03	1.4E+04		3.1E+03
				5.0E-03	I					1	0.1		1.4E+09		Oxadiazon	19666-30-9					3.9E+02	1.4E+03		3.1E+02
				2.5E-02	I					1	0.1		1.4E+09		Oxamyl	23135-22-0					2.0E+03	7.0E+03		1.5E+03
				1.3E-02	I					1	0.1		1.4E+09		Paclobutrazol	76738-62-0					1.0E+03	3.6E+03		7.9E+02
				4.5E-03	I					1	0.1		1.4E+09		Paraquat Dichloride	1910-42-5					3.5E+02	1.3E+03		2.7E+02
				6.0E-03	H					1	0.1		1.4E+09		Parathion	56-38-2					4.7E+02	1.7E+03		3.7E+02
				5.0E-02	H					1	0.1		1.4E+09		Pebulate	1114-71-2					3.9E+03	1.4E+04		3.1E+03
				4.0E-02	I					1	0.1		1.4E+09		Pendimethalin	40487-42-1					3.1E+03	1.1E+04		2.4E+03
				2.0E-03	I					1	0.1		1.4E+09		Pentabromodiphenyl Ether	32534-81-9					1.6E+02	5.6E+02		1.2E+02
				1.0E-04	I					1	0.1		1.4E+09		Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					7.8E+00	2.8E+01		6.1E+00
				8.0E-04	I					1	0.1		1.4E+09		Pentachlorobenzene	608-93-5					6.3E+01	2.2E+02		4.9E+01
9.0E-02	P									1	0.1		1.4E+09		Pentachloroethane	76-01-7	7.1E+00	2.2E+01		5.4E+00				

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
2.6E-01	H			3.0E-03	I					1	0.1		1.4E+09		Pentachloronitrobenzene	82-68-8	2.5E+00	7.8E+00		1.9E+00	2.3E+02	8.4E+02		1.8E+02
4.0E-01	I	5.1E-06	C	5.0E-03	I					1	0.25		1.4E+09		Pentachlorophenol	87-86-5	1.6E+00	2.0E+00	6.5E+05	8.9E-01	3.9E+02	5.6E+02		2.3E+02
4.0E-03	X			2.0E-03	P					1	0.1		1.4E+09		Pentaerythritol tetranitrate (PETN)	78-11-5	1.6E+02	5.1E+02		1.2E+02	1.6E+02	5.6E+02		1.2E+02
						1.0E+00	P	V		1		3.9E+02	1.4E+09	8.4E+02	Pentane, n-	109-66-0							8.7E+02	8.7E+02
															Perchlorates									
				7.0E-04	I					1			1.4E+09		~Ammonium Perchlorate	7790-98-9					5.5E+01			5.5E+01
				7.0E-04	I					1			1.4E+09		~Lithium Perchlorate	7791-03-9					5.5E+01			5.5E+01
				7.0E-04	I					1			1.4E+09		~Perchlorate and Perchlorate Salts	14797-73-0					5.5E+01			5.5E+01
				7.0E-04	I					1			1.4E+09		~Potassium Perchlorate	7778-74-7					5.5E+01			5.5E+01
				7.0E-04	I					1			1.4E+09		~Sodium Perchlorate	7601-89-0					5.5E+01			5.5E+01
				5.0E-02	I					1	0.1		1.4E+09		Permethrin	52645-53-1					3.9E+03	1.4E+04		3.1E+03
2.2E-03	C	6.3E-07	C							1	0.1		1.4E+09		Phenacetin	62-44-2	2.9E+02	9.2E+02	5.3E+06	2.2E+02				
				2.5E-01	I					1	0.1		1.4E+09		Phenmedipham	13684-63-4					2.0E+04	7.0E+04		1.5E+04
				3.0E-01	I	2.0E-01	C			1	0.1		1.4E+09		Phenol	108-95-2					2.3E+04	8.4E+04	2.8E+08	1.8E+04
				5.0E-04	X					1	0.1		1.4E+09		Phenothiazine	92-84-2					3.9E+01	1.4E+02		3.1E+01
				6.0E-03	I					1	0.1		1.4E+09		Phenylenediamine, m-	108-45-2					4.7E+02	1.7E+03		3.7E+02
4.7E-02	H									1	0.1		1.4E+09		Phenylenediamine, o-	95-54-5	1.4E+01	4.3E+01		1.0E+01				
				1.9E-01	H					1	0.1		1.4E+09		Phenylenediamine, p-	106-50-3					1.5E+04	5.3E+04		1.2E+04
1.9E-03	H									1	0.1		1.4E+09		Phenylphenol, 2-	90-43-7	3.3E+02	1.0E+03		2.5E+02				
				2.0E-04	H					1	0.1		1.4E+09		Phorate	298-02-2					1.6E+01	5.6E+01		1.2E+01
						3.0E-04	I	V		1		1.6E+03	1.4E+09	1.1E+03	Phosgene	75-44-5							3.3E-01	3.3E-01
				2.0E-02	I					1	0.1		1.4E+09		Phosmet	732-11-6					1.6E+03	5.6E+03		1.2E+03
															Phosphates, Inorganic									
				4.9E+01	P					1			1.4E+09		~Aluminum metaphosphate	13776-88-0					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Ammonium polyphosphate	68333-79-9					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Calcium pyrophosphate	7790-76-3					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Diammonium phosphate	7783-28-0					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Dicalcium phosphate	7757-93-9					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Dimagnesium phosphate	7782-75-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Dipotassium phosphate	7758-11-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Disodium phosphate	7558-79-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monoaluminum phosphate	13530-50-2					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monoammonium phosphate	7722-76-1					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monocalcium phosphate	7758-23-8					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monomagnesium phosphate	7757-86-0					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monopotassium phosphate	7778-77-0					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Monosodium phosphate	7558-80-7					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Polyphosphoric acid	8017-16-1					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Potassium tripolyphosphate	13845-36-8					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium acid pyrophosphate	7758-16-9					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (acidic)	7785-88-8					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (anhydrous)	10279-59-1					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium hexametaphosphate	10124-56-8					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium polyphosphate	68915-31-1					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium trimetaphosphate	7785-84-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Sodium tripolyphosphate	7758-29-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Tetrapotassium phosphate	7320-34-5					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Tetrasodium pyrophosphate	7722-88-5					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Tricalcium phosphate	7758-87-4					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Trimagnesium phosphate	7757-87-1					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Tripotassium phosphate	7778-53-2					3.8E+06			3.8E+06
				4.9E+01	P					1			1.4E+09		~Trisodium phosphate	7601-54-9					3.8E+06			3.8E+06
				3.0E-04	I	3.0E-04	I			1			1.4E+09		Phosphine	7803-51-2					2.3E+01		4.3E+05	2.3E+01
				4.9E+01	P	1.0E-02	I			1			1.4E+09		Phosphoric Acid	7664-38-2					3.8E+06		1.4E+07	3.0E+06
				2.0E-05	I					1			1.4E+09		Phosphorus, White	7723-14-0					1.6E+00			1.6E+00
				1.0E+00	H					1	0.1		1.4E+09		Phthalic Acid, P-	100-21-0					7.8E+04	2.8E+05		6.1E+04
				2.0E+00	I	2.0E-02	C			1	0.1		1.4E+09		Phthalic Anhydride	85-44-9					1.6E+05	5.6E+05	2.8E+07	1.2E+05
				7.0E-02	I					1	0.1		1.4E+09		Picloram	1918-02-1					5.5E+03	2.0E+04		4.3E+03
				1.0E-04	X					1	0.1		1.4E+09		Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					7.8E+00	2.8E+01		6.1E+00
				1.0E-02	I					1	0.1		1.4E+09		Pirimiphos, Methyl	29232-93-7					7.8E+02	2.8E+03		6.1E+02
3.0E+01	C	8.6E-03	C	7.0E-06	H					1	0.1		1.4E+09		Polybrominated Biphenyls	59536-65-1	2.1E-02	6.7E-02	3.8E+02	1.6E-02	5.5E-01	2.0E+00		4.3E-01
															Polychlorinated Biphenyls (PCBs)									
7.0E-02	S	2.0E-05	S	7.0E-05	I					1	0.14		1.4E+09		~Aroclor 1016	12674-11-2	9.1E+00	2.1E+01	1.7E+05	6.3E+00	5.5E+00	1.4E+01		3.9E+00

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
2.0E+00	S	5.7E-04	S					V		1	0.14	7.6E+02	1.4E+09	9.2E+04	~Aroclor 1221	11104-28-2	3.2E-01	7.2E-01	3.9E-01	1.4E-01				
2.0E+00	S	5.7E-04	S					V		1	0.14	7.3E+01	1.4E+09	9.2E+04	~Aroclor 1232	11141-16-5	3.2E-01	7.2E-01	3.9E-01	1.4E-01				
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1242	53469-21-9	3.2E-01	7.2E-01	5.8E+03	2.2E-01				
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1248	12672-29-6	3.2E-01	7.2E-01	5.8E+03	2.2E-01				
2.0E+00	S	5.7E-04	S	2.0E-05	I					1	0.14		1.4E+09		~Aroclor 1254	11097-69-1	3.2E-01	7.2E-01	5.8E+03	2.2E-01	1.6E+00	4.0E+00		1.1E+00
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1260	11096-82-5	3.2E-01	7.2E-01	5.8E+03	2.2E-01				
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.6E-04	3.7E-04	2.9E+00	1.1E-04	1.8E-03	4.7E-03	1.9E+03	1.3E-03
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.6E-01	3.7E-01	2.9E+03	1.1E-01	1.8E+00	4.7E+00	1.9E+06	1.3E+00
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	4.9E-05	1.1E-04	8.7E-01	3.4E-05	5.5E-04	1.4E-03	5.7E+02	3.9E-04
2.0E+00	I	5.7E-04	I							1	0.14		1.4E+09		~Polychlorinated Biphenyls (high risk)	1336-36-3	3.2E-01	7.2E-01	5.8E+03	2.2E-01				
4.0E-01	I	1.0E-04	I							1	0.14				~Polychlorinated Biphenyls (low risk)	1336-36-3								
7.0E-02	I	2.0E-05	I							1	0.14				~Polychlorinated Biphenyls (lowest risk)	1336-36-3								
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			1	0.14		1.4E+09		~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	4.9E-02	1.1E-01	8.7E+02	3.4E-02	5.5E-01	1.4E+00	5.7E+05	3.9E-01
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E			1	0.14		1.4E+09		~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.6E-02	3.7E-02	2.9E+02	1.1E-02	1.8E-01	4.7E-01	1.9E+05	1.3E-01
						6.0E-04	I			1	0.1		1.4E+09		Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							8.5E+05	8.5E+05
															Polynuclear Aromatic Hydrocarbons (PAHs)									
				6.0E-02	I			V		1	0.13		1.4E+09	1.5E+05	~Acenaphthene	83-32-9					4.7E+03	1.3E+04		3.4E+03
				3.0E-01	I			V		1	0.13		1.4E+09	5.6E+05	~Anthracene	120-12-7					2.3E+04	6.4E+04		1.7E+04
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benz[a]anthracene	56-55-3	2.0E-01	5.3E-01	1.2E+04	1.5E-01				
1.2E+00	C	1.1E-04	C							1	0.13		1.4E+09		~Benzo(j)fluoranthene	205-82-3	5.3E-01	1.3E+00	3.0E+04	3.8E-01				
7.3E+00	I	1.1E-03	C						M	1	0.13		1.4E+09		~Benzo[a]pyrene	50-32-8	2.0E-02	5.3E-02	1.2E+03	1.5E-02				
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benzo[b]fluoranthene	205-99-2	2.0E-01	5.3E-01	1.2E+04	1.5E-01				
7.3E-02	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benzo[k]fluoranthene	207-08-9	2.0E+00	5.3E+00	1.2E+04	1.5E+00				
7.3E-03	E	1.1E-05	C						M	1	0.13		1.4E+09		~Chrysene	218-01-9	2.0E+01	5.3E+01	1.2E+05	1.5E+01				
7.3E+00	E	1.2E-03	C						M	1	0.13		1.4E+09		~Dibenz[a,h]anthracene	53-70-3	2.0E-02	5.3E-02	1.1E+03	1.5E-02				
1.2E+01	C	1.1E-03	C							1	0.13		1.4E+09		~Dibenzo(a,e)pyrene	192-65-4	5.3E-02	1.3E-01	3.0E+03	3.8E-02				
2.5E+02	C	7.1E-02	C						M	1	0.13		1.4E+09		~Dimethylbenz(a)anthracene, 7,12-	57-97-6	6.0E-04	1.6E-03	1.8E+01	4.3E-04				
				4.0E-02	I					1	0.13		1.4E+09		~Fluoranthene	206-44-0					3.1E+03	8.6E+03		2.3E+03
				4.0E-02	I			V		1	0.13		1.4E+09	3.0E+05	~Fluorene	86-73-7					3.1E+03	8.6E+03		2.3E+03
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Indeno[1,2,3-cd]pyrene	193-39-5	2.0E-01	5.3E-01	1.2E+04	1.5E-01				
2.9E-02	P			7.0E-02	A			V		1	0.13		1.4E+09	6.3E+04	~Methylnaphthalene, 1-	90-12-0	2.2E+01	5.4E+01		1.6E+01	5.5E+03	1.5E+04		4.0E+03
				4.0E-03	I			V		1	0.13		1.4E+09	6.2E+04	~Methylnaphthalene, 2-	91-57-6					3.1E+02	8.6E+02		2.3E+02
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		1	0.13		1.4E+09	5.0E+04	~Naphthalene	91-20-3			3.6E+00	3.6E+00	1.6E+03	4.3E+03	1.6E+02	1.4E+02
1.2E+00	C	1.1E-04	C							1	0.13		1.4E+09		~Nitropyrene, 4-	57835-92-4	5.3E-01	1.3E+00	3.0E+04	3.8E-01				
				3.0E-02	I			V		1	0.13		1.4E+09	2.6E+06	~Pyrene	129-00-0					2.3E+03	6.4E+03		1.7E+03
1.5E-01	I			9.0E-03	I					1	0.1		1.4E+09		Prochloraz	67747-09-5	4.3E+00	1.3E+01		3.2E+00	7.0E+02	2.5E+03		5.5E+02
				6.0E-03	H					1	0.1		1.4E+09		Profluralin	26399-36-0					4.7E+02	1.7E+03		3.7E+02
				1.5E-02	I					1	0.1		1.4E+09		Prometon	1610-18-0					1.2E+03	4.2E+03		9.2E+02
				4.0E-03	I					1	0.1		1.4E+09		Prometryn	7287-19-6					3.1E+02	1.1E+03		2.4E+02
				1.3E-02	I					1	0.1		1.4E+09		Propachlor	1918-16-7					1.0E+03	3.6E+03		7.9E+02
				5.0E-03	I					1	0.1		1.4E+09		Propanil	709-98-8					3.9E+02	1.4E+03		3.1E+02
				2.0E-02	I					1	0.1		1.4E+09		Propargite	2312-35-8					1.6E+03	5.6E+03		1.2E+03
				2.0E-03	I					1	0.1		1.4E+09		Propargyl Alcohol	107-19-7					1.6E+02	5.6E+02		1.2E+02
				2.0E-02	I					1	0.1		1.4E+09		Propazine	139-40-2					1.6E+03	5.6E+03		1.2E+03
				2.0E-02	I					1	0.1		1.4E+09		Propham	122-42-9					1.6E+03	5.6E+03		1.2E+03
				1.3E-02	I					1	0.1		1.4E+09		Propiconazole	60207-90-1					1.0E+03	3.6E+03		7.9E+02
						8.0E-03	I	V		1		3.3E+04	1.4E+09	9.6E+03	Propionaldehyde	123-38-6							8.0E+01	8.0E+01
				1.0E-01	X	1.0E+00	X	V		1	0.1	2.6E+02	1.4E+09	7.5E+03	Propyl benzene	103-65-1					7.8E+03	2.8E+04	7.9E+03	3.4E+03
						3.0E+00	C	V		1	0.1	3.5E+02	1.4E+09	7.6E+02	Propylene	115-07-1							2.4E+03	2.4E+03
				2.0E+01	P					1	0.1		1.4E+09		Propylene Glycol	57-55-6					1.6E+06	5.6E+06		1.2E+06
						2.7E-04	A			1	0.1		1.4E+09		Propylene Glycol Dinitrate	6423-43-4							3.9E+05	3.9E+05
				7.0E-01	H					1	0.1		1.4E+09		Propylene Glycol Monoethyl Ether	1569-02-4					5.5E+04	2.0E+05		4.3E+04
				7.0E-01	H	2.0E+00	I			1	0.1		1.4E+09		Propylene Glycol Monomethyl Ether	107-98-2					5.5E+04	2.0E+05	2.8E+09	4.3E+04
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1		7.8E+04	1.4E+09	1.1E+04	Propylene Oxide	75-56-9	2.7E+00		7.3E+00	2.0E+00			3.5E+02	3.5E+02
				2.5E-01	I					1	0.1		1.4E+09		Pursuit	81335-77-5					2.0E+04	7.0E+04		1.5E+04
				2.5E-02	I					1	0.1		1.4E+09		Pydrin	51630-58-1					2.0E+03	7.0E+03		1.5E+03
				1.0E-03	I			V		1		5.3E+05	1.4E+09	6.0E+04	Pyridine	110-86-1					7.8E+01			7.8E+01
				5.0E-04	I					1	0.1		1.4E+09		Quinalphos	13593-03-8					3.9E+01	1.4E+02		3.1E+01

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
3.0E+00	I									1	0.1		1.4E+09		Quinoline	91-22-5	2.1E-01	6.7E-01		1.6E-01				
						3.0E-02	A			1			1.4E+09		Refractory Ceramic Fibers	NA							4.3E+07	4.3E+07
				3.0E-02	I					1	0.1		1.4E+09		Resmethrin	10453-86-8					2.3E+03	8.4E+03		1.8E+03
				5.0E-02	H					1	0.1		1.4E+09		Ronnel	299-84-3					3.9E+03	1.4E+04		3.1E+03
				4.0E-03	I					1	0.1		1.4E+09		Rotenone	83-79-4					3.1E+02	1.1E+03		2.4E+02
2.2E-01	C	6.3E-05	C						M	1	0.1		1.4E+09		Safrole	94-59-7	6.8E-01	2.3E+00	2.1E+04	5.2E-01				
				2.5E-02	I					1	0.1		1.4E+09		Savey	78587-05-0					2.0E+03	7.0E+03		1.5E+03
				5.0E-03	I					1			1.4E+09		Selenious Acid	7783-00-8					3.9E+02			3.9E+02
				5.0E-03	I	2.0E-02	C			1			1.4E+09		Selenium	7782-49-2					3.9E+02		2.8E+07	3.9E+02
				5.0E-03	C	2.0E-02	C			1			1.4E+09		Selenium Sulfide	7446-34-6					3.9E+02		2.8E+07	3.9E+02
				9.0E-02	I					1	0.1		1.4E+09		Sethoxydim	74051-80-2					7.0E+03	2.5E+04		5.5E+03
						3.0E-03	C			1			1.4E+09		Silica (crystalline, respirable)	7631-86-9							4.3E+06	4.3E+06
				5.0E-03	I					0.04			1.4E+09		Silver	7440-22-4					3.9E+02			3.9E+02
1.2E-01	H			5.0E-03	I					1	0.1		1.4E+09		Simazine	122-34-9	5.3E+00	1.7E+01		4.1E+00	3.9E+02	1.4E+03		3.1E+02
				1.3E-02	I					1	0.1		1.4E+09		Sodium Acifluorfen	62476-59-9					1.0E+03	3.6E+03		7.9E+02
				4.0E-03	I					1			1.4E+09		Sodium Azide	26628-22-8					3.1E+02			3.1E+02
2.7E-01	H			3.0E-02	I					1	0.1		1.4E+09		Sodium Diethyldithiocarbamate	148-18-5	2.4E+00	7.5E+00		1.8E+00	2.3E+03	8.4E+03		1.8E+03
				5.0E-02	A	1.3E-02	C			1			1.4E+09		Sodium Fluoride	7681-49-4					3.9E+03		1.8E+07	3.9E+03
				2.0E-05	I					1	0.1		1.4E+09		Sodium Fluoroacetate	62-74-8					1.6E+00	5.6E+00		1.2E+00
				1.0E-03	H					1			1.4E+09		Sodium Metavanadate	13718-26-8					7.8E+01			7.8E+01
2.4E-02	H			3.0E-02	I					1	0.1		1.4E+09		Stirofos (Tetrachlorovinphos)	961-11-5	2.7E+01	8.4E+01		2.0E+01	2.3E+03	8.4E+03		1.8E+03
				6.0E-01	I					1			1.4E+09		Strontium, Stable	7440-24-6					4.7E+04			4.7E+04
				3.0E-04	I					1	0.1		1.4E+09		Strychnine	57-24-9					2.3E+01	8.4E+01		1.8E+01
				2.0E-01	I	1.0E+00	I	V		1		8.7E+02	1.4E+09	1.0E+04	Styrene	100-42-5					1.6E+04		1.0E+04	6.3E+03
				1.0E-03	P	2.0E-03	P			1	0.1		1.4E+09		Sulfolane	126-33-0					7.8E+01	2.8E+02	2.8E+06	6.1E+01
				8.0E-04	P					1	0.1		1.4E+09		Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					6.3E+01	2.2E+02		4.9E+01
						1.0E-03	C			1			1.4E+09		Sulfuric Acid	7664-93-9							1.4E+06	1.4E+06
				2.5E-02	I					1	0.1		1.4E+09		Systhane	88671-89-0					2.0E+03	7.0E+03		1.5E+03
				3.0E-02	H					1	0.1		1.4E+09		TCMTB	21564-17-0					2.3E+03	8.4E+03		1.8E+03
				7.0E-02	I					1	0.1		1.4E+09		Tebuthiuron	34014-18-1					5.5E+03	2.0E+04		4.3E+03
				2.0E-02	H					1	0.1		1.4E+09		Temephos	3383-96-8					1.6E+03	5.6E+03		1.2E+03
				1.3E-02	I					1	0.1		1.4E+09		Terbacil	5902-51-2					1.0E+03	3.6E+03		7.9E+02
				2.5E-05	H					1	0.1		1.4E+09		Terbufos	13071-79-9					2.0E+00	7.0E+00		1.5E+00
				1.0E-03	I					1	0.1		1.4E+09		Terbutryn	886-50-0					7.8E+01	2.8E+02		6.1E+01
				1.0E-04	I					1	0.1		1.4E+09		Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					7.8E+00	2.8E+01		6.1E+00
				3.0E-04	I					1	0.1		1.4E+09		Tetrachlorobenzene, 1,2,4,5-	95-94-3					2.3E+01	8.4E+01		1.8E+01
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		1		6.8E+02	1.4E+09	6.1E+03	Tetrachloroethane, 1,1,1,2-	630-20-6	2.5E+01		2.0E+00	1.9E+00	2.3E+03			2.3E+03
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		1		1.9E+03	1.4E+09	1.6E+04	Tetrachloroethane, 1,1,2,2-	79-34-5	3.2E+00		6.8E-01	5.6E-01	1.6E+03			1.6E+03
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		1		1.7E+02	1.4E+09	2.5E+03	Tetrachloroethylene	127-18-4	3.0E+02		2.4E+01	2.2E+01	4.7E+02		1.1E+02	8.6E+01
				3.0E-02	I					1	0.1		1.4E+09		Tetrachlorophenol, 2,3,4,6-	58-90-2					2.3E+03	8.4E+03		1.8E+03
2.0E+01	H									1	0.1		1.4E+09		Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	3.2E-02	1.0E-01		2.4E-02				
				5.0E-04	I					1	0.1		1.4E+09		Tetraethyl Dithiopyrophosphate	3689-24-5					3.9E+01	1.4E+02		3.1E+01
						8.0E+01	I	V		1		1.1E+03	1.4E+09	1.3E+03	Tetrafluoroethane, 1,1,1,2-	811-97-2							1.1E+05	1.1E+05
				4.0E-03	P					1	0.1		1.4E+09		Tetryl (Trinitrophenylmethylnitramine)	479-45-8					3.1E+02	1.1E+03		2.4E+02
				7.0E-06	X					1			1.4E+09		Thallium (I) Nitrate	10102-45-1					5.5E-01			5.5E-01
				1.0E-05	X					1			1.4E+09		Thallium (Soluble Salts)	7440-28-0					7.8E-01			7.8E-01
				6.0E-06	X					1			1.4E+09		Thallium Acetate	563-68-8					4.7E-01			4.7E-01
				2.0E-05	X					1			1.4E+09		Thallium Carbonate	6533-73-9					1.6E+00			1.6E+00
				6.0E-06	X					1			1.4E+09		Thallium Chloride	7791-12-0					4.7E-01			4.7E-01
				2.0E-05	X					1			1.4E+09		Thallium Sulfate	7446-18-6					1.6E+00			1.6E+00
				1.0E-02	I					1	0.1		1.4E+09		Thiobencarb	28249-77-6					7.8E+02	2.8E+03		6.1E+02
				7.0E-02	X					1	0.008		1.4E+09		Thiodiglycol	111-48-8					5.5E+03	2.6E+05		5.4E+03
				3.0E-04	H					1	0.1		1.4E+09		Thiofanox	39196-18-4					2.3E+01	8.4E+01		1.8E+01
				8.0E-02	I					1	0.1		1.4E+09		Thiophanate, Methyl	23564-05-8					6.3E+03	2.2E+04		4.9E+03
				5.0E-03	I					1	0.1		1.4E+09		Thiram	137-26-8					3.9E+02	1.4E+03		3.1E+02
				6.0E-01	H					1			1.4E+09		Tin	7440-31-5					4.7E+04			4.7E+04
						1.0E-04	A			1			1.4E+09		Titanium Tetrachloride	7550-45-0							1.4E+05	1.4E+05
				8.0E-02	I	5.0E+00	I	V		1		8.2E+02	1.4E+09	4.6E+03	Toluene	108-88-3					6.3E+03		2.4E+04	5.0E+03
1.8E-01	X			2.0E-04	X					1	0.1		1.4E+09		Toluene-2,5-diamine	95-70-5	3.6E+00	1.1E+01		2.7E+00	1.6E+01	5.6E+01		1.2E+01
3.0E-02	P			4.0E-03	X					1	0.1		1.4E+09		Toluidine, p-	106-49-0	2.1E+01	6.7E+01		1.6E+01	3.1E+02	1.1E+03		2.4E+02
1.1E+00	I	3.2E-04	I							1	0.1		1.4E+09		Toxaphene	8001-35-2	5.8E-01	1.8E+00	1.0E+04	4.4E-01				
				7.5E-03	I					1	0.1		1.4E+09		Tralomethrin	66841-25-6					5.9E+02	2.1E+03		4.6E+02
				3.0E-04	A					1	0.1		1.4E+09		Tri-n-butyltin	688-73-3					2.3E+01	8.4E+01		1.8E+01
				8.0E+01	X					1	0.1		1.4E+09		Triacetin	102-76-1					6.3E+06	2.2E+07		4.9E+06
				1.3E-02	I					1	0.1		1.4E+09		Triallate	2303-17-5					1.0E+03	3.6E+03		7.9E+02

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.0E-02	I					1	0.1		1.4E+09		Triasulfuron	82097-50-5					7.8E+02	2.8E+03		6.1E+02
				5.0E-03	I					1	0.1		1.4E+09		Tribromobenzene, 1,2,4-	615-54-3					3.9E+02	1.4E+03		3.1E+02
9.0E-03	P			1.0E-02	P					1	0.1		1.4E+09		Tributyl Phosphate	126-73-8	7.1E+01	2.2E+02		5.4E+01	7.8E+02	2.8E+03		6.1E+02
				3.0E-04	P					1	0.1		1.4E+09		Tributyltin Compounds	NA					2.3E+01	8.4E+01		1.8E+01
				3.0E-04	I					1	0.1		1.4E+09		Tributyltin Oxide	56-35-9					2.3E+01	8.4E+01		1.8E+01
				3.0E+01	I	3.0E+01	H	V		1		9.1E+02	1.4E+09	1.4E+03	Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					2.3E+06		4.3E+04	4.3E+04
7.0E-02	I			2.0E-02	I					1	0.1		1.4E+09		Trichloroacetic Acid	76-03-9	9.1E+00	2.9E+01		6.9E+00	1.6E+03	5.6E+03		1.2E+03
2.9E-02	H									1	0.1		1.4E+09		Trichloroaniline HCl, 2,4,6-	33663-50-2	2.2E+01	7.0E+01		1.7E+01				
7.0E-03	X			3.0E-05	X					1	0.1		1.4E+09		Trichloroaniline, 2,4,6-	634-93-5	9.1E+01	2.9E+02		6.9E+01	2.3E+00	8.4E+00		1.8E+00
				8.0E-04	X			V		1	0.1		1.4E+09	3.5E+04	Trichlorobenzene, 1,2,3-	87-61-6					6.3E+01	2.2E+02		4.9E+01
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1		4.0E+02	1.4E+09	3.2E+04	Trichlorobenzene, 1,2,4-	120-82-1	2.2E+01			2.2E+01	7.8E+02		6.7E+01	6.2E+01
				2.0E+00	I	5.0E+00	I	V		1		6.4E+02	1.4E+09	1.8E+03	Trichloroethane, 1,1,1-	71-55-6					1.6E+05		9.3E+03	8.7E+03
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1		2.2E+03	1.4E+09	7.8E+03	Trichloroethane, 1,1,2-	79-00-5	1.1E+01		1.2E+00	1.1E+00	3.1E+02		1.6E+00	1.6E+00
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	1		6.9E+02	1.4E+09	2.4E+03	Trichloroethylene	79-01-6	8.3E+00		1.0E+00	9.1E-01	3.9E+01		5.0E+00	4.4E+00
				3.0E-01	I	7.0E-01	H	V		1		1.2E+03	1.4E+09	1.1E+03	Trichlorofluoromethane	75-69-4					2.3E+04		8.1E+02	7.9E+02
				1.0E-01	I					1	0.1		1.4E+09		Trichlorophenol, 2,4,5-	95-95-4					7.8E+03	2.8E+04		6.1E+03
1.1E-02	I	3.1E-06	I	1.0E-03	P					1	0.1		1.4E+09		Trichlorophenol, 2,4,6-	88-06-2	5.8E+01	1.8E+02	1.1E+06	4.4E+01	7.8E+01	2.8E+02		6.1E+01
				1.0E-02	I					1	0.1		1.4E+09		Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					7.8E+02	2.8E+03		6.1E+02
				8.0E-03	I					1	0.1		1.4E+09		Trichlorophenoxypropionic acid, -2,4,5	93-72-1					6.3E+02	2.2E+03		4.9E+02
				5.0E-03	I			V		1		1.3E+03	1.4E+09	1.6E+04	Trichloropropane, 1,1,2-	598-77-6					3.9E+02			3.9E+02
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1		1.4E+03	1.4E+09	1.7E+04	Trichloropropane, 1,2,3-	96-18-4	5.0E-03			5.0E-03	3.1E+02		5.3E+00	5.2E+00
				3.0E-03	X	3.0E-04	P	V		1		4.5E+02	1.4E+09	2.5E+03	Trichloropropene, 1,2,3-	96-19-5					2.3E+02		7.9E-01	7.8E-01
				2.0E-02	A					1	0.1		1.4E+09		Tricresyl Phosphate (TCP)	1330-78-5						5.6E+03		5.6E+03
				3.0E-03	I					1	0.1		1.4E+09		Tridiphane	58138-08-2					2.3E+02	8.4E+02		1.8E+02
						7.0E-03	I	V		1		2.8E+04	1.4E+09	1.7E+04	Triethylamine	121-44-8							1.2E+02	1.2E+02
7.7E-03	I			7.5E-03	I					1	0.1		1.4E+09		Trifluralin	1582-09-8	8.3E+01	2.6E+02		6.3E+01	5.9E+02	2.1E+03		4.6E+02
2.0E-02	P			1.0E-02	P					1	0.1		1.4E+09		Trimethyl Phosphate	512-56-1	3.2E+01	1.0E+02		2.4E+01	7.8E+02	2.8E+03		6.1E+02
						5.0E-03	P	V		1		2.9E+02	1.4E+09	1.0E+04	Trimethylbenzene, 1,2,3-	526-73-8							5.3E+01	5.3E+01
						7.0E-03	P	V		1		2.2E+02	1.4E+09	8.5E+03	Trimethylbenzene, 1,2,4-	95-63-6							6.2E+01	6.2E+01
				1.0E-02	X			V		1		1.8E+02	1.4E+09	7.1E+03	Trimethylbenzene, 1,3,5-	108-67-8					7.8E+02			7.8E+02
				3.0E-02	I					1	0.019		1.4E+09		Trinitrobenzene, 1,3,5-	99-35-4					2.3E+03	4.4E+04		2.2E+03
3.0E-02	I			5.0E-04	I					1	0.032		1.4E+09		Trinitrotoluene, 2,4,6-	118-96-7	2.1E+01	2.1E+02		1.9E+01	3.9E+01	4.4E+02		3.6E+01
				2.0E-02	P					1	0.1		1.4E+09		Triphenylphosphine Oxide	791-28-6					1.6E+03	5.6E+03		1.2E+03
				2.0E-02	A					1	0.1		1.4E+09		Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					1.6E+03	5.6E+03		1.2E+03
				1.0E-02	X					1	0.1		1.4E+09		Tris(1-chloro-2-propyl)phosphate	13674-84-5					7.8E+02	2.8E+03		6.1E+02
2.0E-02	P			7.0E-03	P					1	0.1		1.4E+09		Tris(2-chloroethyl)phosphate	115-96-8	3.2E+01	1.0E+02		2.4E+01	5.5E+02	2.0E+03		4.3E+02
3.2E-03	P			1.0E-01	P					1	0.1		1.4E+09		Tris(2-ethylhexyl)phosphate	78-42-2	2.0E+02	6.3E+02		1.5E+02	7.8E+03	2.8E+04		6.1E+03
				3.0E-03	I	4.0E-05	A			1			1.4E+09		Uranium (Soluble Salts)	NA					2.3E+02		5.7E+04	2.3E+02
1.0E+00	C	2.9E-04	C						M	1	0.1		1.4E+09		Urethane	51-79-6	1.5E-01	5.1E-01	4.5E+03	1.2E-01				
		8.3E-03	P	9.0E-03	I	7.0E-06	P			0.026			1.4E+09		Vanadium Pentoxide	1314-62-1			4.0E+02	4.0E+02	7.0E+02		9.9E+03	6.6E+02
				5.0E-03	S	1.0E-04	A			0.026			1.4E+09		Vanadium and Compounds	7440-62-2					3.9E+02		1.4E+05	3.9E+02
				1.0E-03	I					1	0.1		1.4E+09		Vernolate	1929-77-7					7.8E+01	2.8E+02		6.1E+01
				2.5E-02	I					1	0.1		1.4E+09		Vinclozolin	50471-44-8					2.0E+03	7.0E+03		1.5E+03
				1.0E+00	H	2.0E-01	I	V		1		2.8E+03	1.4E+09	4.7E+03	Vinyl Acetate	108-05-4					7.8E+04		9.9E+02	9.7E+02
		3.2E-05	H			3.0E-03	I	V		1		3.4E+03	1.4E+09	1.5E+03	Vinyl Bromide	593-60-2			1.1E-01	1.1E-01			4.6E+00	4.6E+00
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1		3.9E+03	1.4E+09	1.0E+03	Vinyl Chloride	75-01-4	9.3E-02		1.7E-01	6.0E-02	2.3E+02		1.1E+02	7.4E+01
				3.0E-04	I					1	0.1		1.4E+09		Warfarin	81-81-2					2.3E+01	8.4E+01		1.8E+01
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	1.4E+09	6.0E+03	Xylene, P-	106-42-3					1.6E+04		6.3E+02	6.0E+02
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	1.4E+09	5.9E+03	Xylene, m-	108-38-3					1.6E+04		6.1E+02	5.9E+02
				2.0E-01	S	1.0E-01	S	V		1		4.3E+02	1.4E+09	7.0E+03	Xylene, o-	95-47-6					1.6E+04		7.2E+02	6.9E+02
				2.0E-01	I	1.0E-01	I	V		1		2.6E+02	1.4E+09	6.3E+03	Xylenes	1330-20-7					1.6E+04		6.5E+02	6.3E+02
				3.0E-04	I					1			1.4E+09		Zinc Phosphide	1314-84-7					2.3E+01			2.3E+01
				3.0E-01	I					1			1.4E+09		Zinc and Compounds	7440-66-6					2.3E+04			2.3E+04
				5.0E-02	I					1	0.1		1.4E+09		Zineb	12122-67-7					3.9E+03	1.4E+04		3.1E+03
				8.0E-05	X					1			1.4E+09		Zirconium	7440-67-7					6.3E+00			6.3E+00

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	volc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
1.8E-02	C	5.1E-06	C	1.5E-01	I					1	0.1		1.4E+09		ALAR	1596-84-5	1.6E+02	2.4E+02	3.3E+06	9.6E+01	1.5E+05	2.3E+05		9.2E+04
8.7E-03	I			4.0E-03	I					1	0.1		1.4E+09		Acephate	30560-19-1	3.3E+02	5.0E+02		2.0E+02	4.1E+03	6.2E+03		2.5E+03
		2.2E-06	I			9.0E-03	I	V		1		1.1E+05	1.4E+09	9.4E+03	Acetaldehyde	75-07-0			5.2E+01	5.2E+01			3.7E+02	3.7E+02
				2.0E-02	I					1	0.1		1.4E+09		Acetochlor	34256-82-1					2.0E+04	3.1E+04		1.2E+04
				9.0E-01	I	3.1E+01	A	V		1		1.1E+05	1.4E+09	1.5E+04	Acetone	67-64-1					9.2E+05		2.0E+06	6.3E+05
						2.0E-03	X	V		1		1.1E+05	1.4E+09	2.6E+04	Acetone Cyanohydrin	75-86-5							2.2E+02	2.2E+02
						6.0E-02	I	V		1		1.3E+05	1.4E+09	1.4E+04	Acetonitrile	75-05-8							3.7E+03	3.7E+03
				1.0E-01	I			V		1		2.5E+03	1.4E+09	6.4E+04	Acetophenone	98-86-2					1.0E+05			1.0E+05
3.8E+00	C	1.3E-03	C							1	0.1		1.4E+09		Acetylaminofluorene, 2-	53-96-3	7.5E-01	1.1E+00	1.3E+04	4.5E-01				
				5.0E-04	I	2.0E-05	I	V		1		2.3E+04	1.4E+09	7.4E+03	Acrolein	107-02-8					5.1E+02		6.5E-01	6.5E-01
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	1	0.1		1.4E+09		Acrylamide	79-06-1	5.7E+00	8.7E+00	1.7E+05	3.4E+00	2.0E+03	3.1E+03	3.6E+07	1.2E+03
				5.0E-01	I	1.0E-03	I			1	0.1		1.4E+09		Acrylic Acid	79-10-7					5.1E+05	7.7E+05	6.0E+06	2.9E+05
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		1		1.1E+04	1.4E+09	8.3E+03	Acrylonitrile	107-13-1	5.3E+00		1.5E+00	1.2E+00	4.1E+04		7.2E+01	7.2E+01
						6.0E-03	P			1	0.1		1.4E+09		Adiponitrile	111-69-3							3.6E+07	3.6E+07
5.6E-02	C			1.0E-02	I					1	0.1		1.4E+09		Alachlor	15972-60-8	5.1E+01	7.7E+01		3.1E+01	1.0E+04	1.5E+04		6.2E+03
				1.0E-03	I					1	0.1		1.4E+09		Aldicarb	116-06-3					1.0E+03	1.5E+03		6.2E+02
				1.0E-03	I					1	0.1		1.4E+09		Aldicarb Sulfone	1646-88-4					1.0E+03	1.5E+03		6.2E+02
										1	0.1		1.4E+09		Aldicarb sulfoxide	1646-87-3								
1.7E+01	I	4.9E-03	I	3.0E-05	I					1	0.1		1.4E+09		Aldrin	309-00-2	1.7E-01	2.6E-01	3.4E+03	1.0E-01	3.1E+01	4.6E+01		1.8E+01
				2.5E-01	I					1	0.1		1.4E+09		Ally	74223-64-6					2.6E+05	3.9E+05		1.5E+05
				5.0E-03	I	1.0E-04	X			1	0.1		1.4E+09		Allyl Alcohol	107-18-6					5.1E+03	7.7E+03	6.0E+05	3.1E+03
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1		1.4E+03	1.4E+09	1.7E+03	Allyl Chloride	107-05-1	1.4E+02		3.5E+00	3.4E+00			7.5E+00	7.5E+00
				1.0E+00	P	5.0E-03	P			1			1.4E+09		Aluminum	7429-90-5					1.0E+06		3.0E+07	9.9E+05
				4.0E-04	I					1			1.4E+09		Aluminum Phosphide	20859-73-8					4.1E+02			4.1E+02
				3.0E-04	I					1	0.1		1.4E+09		Amdro	67485-29-4					3.1E+02	4.6E+02		1.8E+02
				9.0E-03	I					1	0.1		1.4E+09		Ametryn	834-12-8					9.2E+03	1.4E+04		5.5E+03
2.1E+01	C	6.0E-03	C							1	0.1		1.4E+09		Aminobiphenyl, 4-	92-67-1	1.4E-01	2.1E-01	2.8E+03	8.2E-02				
				8.0E-02	P					1	0.1		1.4E+09		Aminophenol, m-	591-27-5					8.2E+04	1.2E+05		4.9E+04
				2.0E-02	P					1	0.1		1.4E+09		Aminophenol, p-	123-30-8					2.0E+04	3.1E+04		1.2E+04
				2.5E-03	I					1	0.1		1.4E+09		Amitraz	33089-61-1					2.6E+03	3.9E+03		1.5E+03
						1.0E-01	I			1					Ammonia	7664-41-7								
				2.0E-01	I					1			1.4E+09		Ammonium Sulfamate	7773-06-0					2.0E+05			2.0E+05
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			1	0.1		1.4E+09		Aniline	62-53-3	5.0E+02	7.6E+02	1.0E+07	3.0E+02	7.2E+03	1.1E+04	6.0E+06	4.3E+03
4.0E-02	P			2.0E-03	X					1	0.1		1.4E+09		Anthraquinone, 9,10-	84-65-1	7.2E+01	1.1E+02		4.3E+01	2.0E+03	3.1E+03		1.2E+03
				4.0E-04	I					0.15			1.4E+09		Antimony (metallic)	7440-36-0					4.1E+02			4.1E+02
				5.0E-04	H					0.15			1.4E+09		Antimony Pentoxide	1314-60-9					5.1E+02			5.1E+02
				9.0E-04	H					0.15			1.4E+09		Antimony Potassium Tartrate	11071-15-1					9.2E+02			9.2E+02
				4.0E-04	H					0.15			1.4E+09		Antimony Tetroxide	1332-81-6					4.1E+02			4.1E+02
						2.0E-04	I			0.15			1.4E+09		Antimony Trioxide	1309-64-4							1.2E+06	1.2E+06
				1.3E-02	I					1	0.1		1.4E+09		Apollo	74115-24-5					1.3E+04	2.0E+04		8.0E+03
2.5E-02	I	7.1E-06	I	5.0E-02	H					1	0.1		1.4E+09		Aramite	140-57-8	1.1E+02	1.7E+02	2.3E+06	6.9E+01	5.1E+04	7.7E+04		3.1E+04
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			1	0.03		1.4E+09		Arsenic, Inorganic	7440-38-2	3.2E+00	9.6E+00	3.9E+03	2.4E+00	5.1E+02	1.5E+03	8.9E+04	3.8E+02
				3.5E-06	C	5.0E-05	I			1			1.4E+09		Arsine	7784-42-1					3.6E+00		3.0E+05	3.6E+00
				9.0E-03	I					1	0.1		1.4E+09		Assure	76578-14-8					9.2E+03	1.4E+04		5.5E+03
				5.0E-02	I					1	0.1		1.4E+09		Asulam	3337-71-1					5.1E+04	7.7E+04		3.1E+04
2.3E-01	C			3.5E-02	I					1	0.1		1.4E+09		Atrazine	1912-24-9	1.2E+01	1.9E+01		7.5E+00	3.6E+04	5.4E+04		2.2E+04
8.8E-01	C	2.5E-04	C							1	0.1		1.4E+09		Auramine	492-80-8	3.3E+00	4.9E+00	6.7E+04	2.0E+00				
				4.0E-04	I					1	0.1		1.4E+09		Avermectin B1	65195-55-3					4.1E+02	6.2E+02		2.5E+02
1.1E-01	I	3.1E-05	I					V		1			1.4E+09	5.6E+05	Azobenzene	103-33-3	2.6E+01		2.2E+02	2.3E+01				
				2.0E-01	I	5.0E-04	H			0.07			1.4E+09		Barium	7440-39-3					2.0E+05		3.0E+06	1.9E+05
				4.0E-03	I					1	0.1		1.4E+09		Baygon	114-26-1					4.1E+03	6.2E+03		2.5E+03
				3.0E-02	I					1	0.1		1.4E+09		Bayleton	43121-43-3					3.1E+04	4.6E+04		1.8E+04
				2.5E-02	I					1	0.1		1.4E+09		Baythroid	68359-37-5					2.6E+04	3.9E+04		1.5E+04
				3.0E-01	I					1	0.1		1.4E+09		Benefin	1861-40-1					3.1E+05	4.6E+05		1.8E+05
				5.0E-02	I					1	0.1		1.4E+09		Benomyl	17804-35-2					5.1E+04	7.7E+04		3.1E+04
				3.0E-02	I					1	0.1		1.4E+09		Bentazon	25057-89-0					3.1E+04	4.6E+04		1.8E+04
				1.0E-01	I			V		1		1.2E+03	1.4E+09	2.4E+04	Benzaldehyde	100-52-7					1.0E+05			1.0E+05
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1		1.8E+03	1.4E+09	3.8E+03	Benzene	71-43-2	5.2E+01		6.0E+00	5.4E+00	4.1E+03		5.0E+02	4.5E+02
1.0E-01	X			3.0E-04	X					1	0.1		1.4E+09		Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	2.9E+01	4.3E+01		1.7E+01	3.1E+02	4.6E+02		1.8E+02
				1.0E-03	P			V		1		1.3E+03	1.4E+09	2.1E+04	Benzenethiol	108-98-5					1.0E+03			1.0E+03
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1	0.1		1.4E+09		Benzidine	92-87-5	1.2E-02	1.9E-02	2.5E+02	7.5E-03	3.1E+03	4.6E+03		1.8E+03
				4.0E+00	I					1	0.1		1.4E+09		Benzoic Acid	65-85-0					4.1E+06	6.2E+06		2.5E+06
1.3E+01	I							V		1		3.2E+02	1.4E+09	7.3E+04	Benzotrichloride	98-07-7	2.2E-01			2.2E-01				
				1.0E-01	P					1	0.1		1.4E+09		Benzyl Alcohol	100-51-6					1.0E+05	1.5E+05		6.2E+04
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1		1.5E+03	1.4E+09	2.7E+04	Benzyl Chloride	100-44-7	1.7E+01		6.9E+00	4.9E+00	2.0E+03		1.2E+02	1.1E+02

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vo c	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
		2.4E-03	I	2.0E-03	I	2.0E-05	I			0.007			1.4E+09		Beryllium and compounds	7440-41-7			6.9E+03	6.9E+03	2.0E+03		1.2E+05	2.0E+03
				1.0E-04	I					1	0.1		1.4E+09		Bidrin	141-66-2					1.0E+02	1.5E+02		6.2E+01
				9.0E-03	P					1	0.1		1.4E+09		Bifenox	42576-02-3					9.2E+03	1.4E+04		5.5E+03
				1.5E-02	I					1	0.1		1.4E+09		Biphenthrin	82657-04-3					1.5E+04	2.3E+04		9.2E+03
8.0E-03	X			5.0E-02	I	4.0E-04	X	V		1			1.4E+09	1.2E+05	Biphenyl, 1,1'-	92-52-4	3.6E+02			3.6E+02	5.1E+04		2.1E+02	2.1E+02
7.0E-02	H	1.0E-05	H	4.0E-02	I			V		1		1.0E+03	1.4E+09	3.8E+04	Bis(2-chloro-1-methylethyl) ether	108-60-1	4.1E+01		4.6E+01	2.2E+01	4.1E+04			4.1E+04
				3.0E-03	P					1	0.1		1.4E+09		Bis(2-chloroethoxy)methane	111-91-1					3.1E+03	4.6E+03		1.8E+03
1.1E+00	I	3.3E-04	I					V		1		5.1E+03	1.4E+09	4.6E+04	Bis(2-chloroethyl)ether	111-44-4	2.6E+00		1.7E+00	1.0E+00				
1.4E-02	I	2.4E-06	C	2.0E-02	I					1	0.1		1.4E+09		Bis(2-ethylhexyl)phthalate	117-81-7	2.0E+02	3.1E+02	6.9E+06	1.2E+02	2.0E+04	3.1E+04		1.2E+04
2.2E+02	I	6.2E-02	I					V		1		4.2E+03	1.4E+09	2.0E+03	Bis(chloromethyl)ether	542-88-1	1.3E-02		4.0E-04	3.9E-04				
				5.0E-02	I					1	0.1		1.4E+09		Bisphenol A	80-05-7					5.1E+04	7.7E+04		3.1E+04
				2.0E-01	I	2.0E-02	H			1			1.4E+09		Boron And Borates Only	7440-42-8					2.0E+05		1.2E+08	2.0E+05
				2.0E+00	P	2.0E-02	P			1			1.4E+09		Boron Trichloride	10294-34-5					2.0E+06		1.2E+08	2.0E+06
				4.0E-02	C	1.3E-02	C			1			1.4E+09		Boron Trifluoride	7637-07-2					4.1E+04		7.7E+07	4.1E+04
7.0E-01	I			4.0E-03	I					1			1.4E+09		Bromate	15541-45-4	4.1E+00			4.1E+00	4.1E+03			4.1E+03
2.0E+00	X	6.0E-04	X					V		1		2.4E+03	1.4E+09	6.4E+03	Bromo-2-chloroethane, 1-	107-04-0	1.4E+00		1.3E-01	1.2E-01				
				8.0E-03	I	6.0E-02	I	V		1		6.8E+02	1.4E+09	9.0E+03	Bromobenzene	108-86-1					8.2E+03		2.4E+03	1.8E+03
						4.0E-02	X	V		1		4.0E+03	1.4E+09	3.9E+03	Bromochloromethane	74-97-5							6.8E+02	6.8E+02
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		1		9.3E+02	1.4E+09	4.3E+03	Bromodichloromethane	75-27-4	4.6E+01		1.4E+00	1.4E+00	2.0E+04			2.0E+04
7.9E-03	I	1.1E-06	I	2.0E-02	I					1	0.1		1.4E+09		Bromoform	75-25-2	3.6E+02	5.5E+02	1.5E+07	2.2E+02	2.0E+04	3.1E+04		1.2E+04
				1.4E-03	I	5.0E-03	I	V		1		3.6E+03	1.4E+09	1.5E+03	Bromomethane	74-83-9					1.4E+03		3.3E+01	3.2E+01
				5.0E-03	H					1	0.1		1.4E+09		Bromophos	2104-96-3					5.1E+03	7.7E+03		3.1E+03
				2.0E-02	I					1	0.1		1.4E+09		Bromoxynil	1689-84-5					2.0E+04	3.1E+04		1.2E+04
				2.0E-02	I					1	0.1		1.4E+09		Bromoxynil Octanoate	1689-99-2					2.0E+04	3.1E+04		1.2E+04
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1		6.7E+02	1.4E+09	9.3E+02	Butadiene, 1,3-	106-99-0	8.4E-01		3.8E-01	2.6E-01			8.2E+00	8.2E+00
				1.0E-01	I					1	0.1		1.4E+09		Butanol, N-	71-36-3					1.0E+05	1.5E+05		6.2E+04
1.9E-03	P			2.0E-01	I					1	0.1		1.4E+09		Butyl Benzyl Phthlate	85-68-7	1.5E+03	2.3E+03		9.1E+02	2.0E+05	3.1E+05		1.2E+05
				2.0E+00	P	3.0E+01	P			1	0.1		1.4E+09		Butyl alcohol, sec-	78-92-2					2.0E+06	3.1E+06	1.8E+11	1.2E+06
				5.0E-02	I					1	0.1		1.4E+09		Butylate	2008-41-5					5.1E+04	7.7E+04		3.1E+04
2.0E-04	C	5.7E-08	C							1	0.1		1.4E+09		Butylated hydroxyanisole	25013-16-5	1.4E+04	2.2E+04	2.9E+08	8.6E+03				
				5.0E-02	P			V		1		1.1E+02	1.4E+09	8.8E+03	Butylbenzene, n-	104-51-8					5.1E+04			5.1E+04
				1.0E-01	X			V		1		1.5E+02	1.4E+09	7.9E+03	Butylbenzene, sec-	135-98-8					1.0E+05			1.0E+05
				1.0E-01	X			V		1		1.8E+02	1.4E+09	7.9E+03	Butylbenzene, tert-	98-06-6					1.0E+05			1.0E+05
				1.0E+00	I					1	0.1		1.4E+09		Butylphthalyl Butylglycolate	85-70-1					1.0E+06	1.5E+06		6.2E+05
				2.0E-02	A					1	0.1		1.4E+09		Cacodylic Acid	75-60-5					2.0E+04	3.1E+04		1.2E+04
		1.8E-03	I	1.0E-03	I	1.0E-05	A			0.025	0.001		1.4E+09		Cadmium (Diet)	7440-43-9			9.3E+03	9.3E+03	1.0E+03	3.9E+03	6.0E+04	8.0E+02
		1.8E-03	I	5.0E-04	I	1.0E-05	A			0.05	0.001				Cadmium (Water)	7440-43-9								
				5.0E-01	I					1	0.1		1.4E+09		Caprolactam	105-60-2					5.1E+05	7.7E+05		3.1E+05
1.5E-01	C	4.3E-05	C	2.0E-03	I					1	0.1		1.4E+09		Captafol	2425-06-1	1.9E+01	2.9E+01	3.9E+05	1.1E+01	2.0E+03	3.1E+03		1.2E+03
2.3E-03	C	6.6E-07	C	1.3E-01	I					1	0.1		1.4E+09		Captan	133-06-2	1.2E+03	1.9E+03	2.5E+07	7.5E+02	1.3E+05	2.0E+05		8.0E+04
				1.0E-01	I					1	0.1		1.4E+09		Carbaryl	63-25-2					1.0E+05	1.5E+05		6.2E+04
				5.0E-03	I					1	0.1		1.4E+09		Carbofuran	1563-66-2					5.1E+03	7.7E+03		3.1E+03
				1.0E-01	I	7.0E-01	I	V		1		7.4E+02	1.4E+09	1.3E+03	Carbon Disulfide	75-15-0					1.0E+05		3.9E+03	3.7E+03
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		1		4.6E+02	1.4E+09	1.6E+03	Carbon Tetrachloride	56-23-5	4.1E+01		3.3E+00	3.0E+00	4.1E+03		7.0E+02	6.0E+02
				1.0E-02	I					1	0.1		1.4E+09		Carbosulfan	55285-14-8					1.0E+04	1.5E+04		6.2E+03
				1.0E-01	I					1	0.1		1.4E+09		Carboxin	5234-68-4					1.0E+05	1.5E+05		6.2E+04
						9.0E-04	I			1			1.4E+09		Ceric oxide	1306-38-3							5.4E+06	5.4E+06
				1.0E-01	I					1	0.1		1.4E+09		Chloral Hydrate	302-17-0					1.0E+05	1.5E+05		6.2E+04
				1.5E-02	I					1	0.1		1.4E+09		Chloramben	133-90-4					1.5E+04	2.3E+04		9.2E+03
4.0E-01	H									1	0.1		1.4E+09		Chloranil	118-75-2	7.1E+00	1.1E+01		4.3E+00				
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			1	0.04		1.4E+09		Chlordane	12789-03-6	8.2E+00	3.1E+01	1.7E+05	6.5E+00	5.1E+02	1.9E+03	4.2E+06	4.0E+02
1.0E+01	I	4.6E-03	C	3.0E-04	I					1	0.1		1.4E+09		Chlordecone (Kepone)	143-50-0	2.9E-01	4.3E-01	3.6E+03	1.7E-01	3.1E+02	4.6E+02		1.8E+02
				7.0E-04	A					1	0.1		1.4E+09		Chlorfenvinphos	470-90-6					7.2E+02	1.1E+03		4.3E+02
				2.0E-02	I					1	0.1		1.4E+09		Chlorimuron, Ethyl-	90982-32-4					2.0E+04	3.1E+04		1.2E+04
				1.0E-01	I	1.5E-04	A			1			1.4E+09		Chlorine	7782-50-5					1.0E+05		8.6E+05	9.1E+04
				3.0E-02	I	2.0E-04	I			1			1.4E+09		Chlorine Dioxide	10049-04-4					3.1E+04		1.2E+06	3.0E+04
				3.0E-02	I					1			1.4E+09		Chlorite (Sodium Salt)	7758-19-2					3.1E+04			3.1E+04
						5.0E+01	I	V		1		1.2E+03	1.4E+09	1.1E+03	Chloro-1,1-difluoroethane, 1-	75-68-3							2.4E+05	2.4E+05
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		1		7.5E+02	1.4E+09	1.2E+03	Chloro-1,3-butadiene, 2-	126-99-8			4.7E-02	4.7E-02	2.0E+04		1.0E+02	1.0E+02
4.6E-01	H									1	0.1		1.4E+09		Chloro-2-methylaniline HCl, 4-	3165-93-3	6.2E+00	9.4E+00		3.7E+00				
1.0E-01	P	7.7E-05	C	3.0E-03	X					1	0.1		1.4E+09		Chloro-2-methylaniline, 4-	95-69-2	2.9E+01	4.3E+01	2.2E+05	1.7E+01	3.1E+03	4.6E+03		1.8E+03
2.7E-01	X							V		1	0.1	2.8E+04	1.4E+09	2.0E+04	Chloroacetaldehyde, 2-	107-20-0	1.1E+01	1.6E+01		6.4E+00				
				2.0E-03	H					1	0.1		1.4E+09		Chloroacetic Acid	79-11-8					2.0E+03	3.1E+03		1.2E+03
						3.0E-05	I			1	0.1		1.4E+09		Chloroacetophenone, 2-	532-27-4							1.8E+05	1.8E+05
2.0E-01	P			4.0E-03	I					1	0.1		1.4E+09		Chloroaniline, p-	106-47-8	1.4E+01	2.2E+01		8.6E+00	4.1E+03	6.2E+03		2.5E+03

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-02	I	5.0E-02	P	V		1		7.6E+02	1.4E+09	6.9E+03	Chlorobenzene	108-90-7					2.0E+04		1.5E+03	1.4E+03
1.1E-01	C	3.1E-05	C	2.0E-02	I					1	0.1		1.4E+09		Chlorobenzilate	510-15-6	2.6E+01	3.9E+01	5.4E+05	1.6E+01	2.0E+04	3.1E+04		1.2E+04
				3.0E-02	X					1	0.1		1.4E+09		Chlorobenzoic Acid, p-	74-11-3					3.1E+04	4.6E+04		1.8E+04
				3.0E-03	P	3.0E-01	P	V		1		1.2E+02	1.4E+09	7.3E+03	Chlorobenzotrifluoride, 4-	98-56-6					3.1E+03		9.6E+03	2.3E+03
				4.0E-02	P			V		1		7.3E+02	1.4E+09	1.9E+03	Chlorobutane, 1-	109-69-3					4.1E+04			4.1E+04
						5.0E+01	I	V		1		1.7E+03	1.4E+09	1.0E+03	Chlorodifluoromethane	75-45-6							2.2E+05	2.2E+05
				2.0E-02	P					1	0.1		1.4E+09		Chloroethanol, 2-	107-07-3					2.0E+04	3.1E+04		1.2E+04
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1		2.5E+03	1.4E+09	2.8E+03	Chloroform	67-66-3	9.2E+01		1.5E+00	1.5E+00	1.0E+04		1.2E+03	1.1E+03
						9.0E-02	I	V		1		1.3E+03	1.4E+09	1.3E+03	Chloromethane	74-87-3							5.0E+02	5.0E+02
2.4E+00	C	6.9E-04	C					V		1		2.6E+04	1.4E+09	5.7E+03	Chloromethyl Methyl Ether	107-30-2	1.2E+00		1.0E-01	9.4E-02				
				8.0E-02	I			V		1			1.4E+09	8.6E+04	Chloronaphthalene, Beta-	91-58-7					8.2E+04			8.2E+04
3.0E-01	P			3.0E-03	P	1.0E-05	X			1	0.1		1.4E+09		Chloronitrobenzene, o-	88-73-3	9.5E+00	1.4E+01		5.7E+00	3.1E+03	4.6E+03	6.0E+04	1.8E+03
6.3E-03	P			1.0E-03	P	6.0E-04	P			1	0.1		1.4E+09		Chloronitrobenzene, p-	100-00-5	4.5E+02	6.9E+02		2.7E+02	1.0E+03	1.5E+03	3.6E+06	6.2E+02
				5.0E-03	I			V		1		2.2E+04	1.4E+09	1.3E+05	Chlorophenol, 2-	95-57-8					5.1E+03			5.1E+03
						4.0E-04	C	V		1		6.2E+02	1.4E+09	5.0E+03	Chloropicrin	76-06-2							8.8E+00	8.8E+00
3.1E-03	C	8.9E-07	C	1.5E-02	I					1	0.1		1.4E+09		Chlorothalonil	1897-45-6	9.2E+02	1.4E+03	1.9E+07	5.6E+02	1.5E+04	2.3E+04		9.2E+03
				2.0E-02	I			V		1		9.1E+02	1.4E+09	8.7E+03	Chlorotoluene, o-	95-49-8					2.0E+04			2.0E+04
				2.0E-02	X			V		1		2.5E+02	1.4E+09	7.9E+03	Chlorotoluene, p-	106-43-4					2.0E+04			2.0E+04
2.4E+02	C	6.9E-02	C							1	0.1		1.4E+09		Chlorozotocin	54749-90-5	1.2E-02	1.8E-02	2.4E+02	7.2E-03				
				2.0E-01	I					1	0.1		1.4E+09		Chlorpropham	101-21-3					2.0E+05	3.1E+05		1.2E+05
				1.0E-03	A					1	0.1		1.4E+09		Chlorpyrifos	2921-88-2					1.0E+03	1.5E+03		6.2E+02
				1.0E-02	H					1	0.1		1.4E+09		Chlorpyrifos Methyl	5598-13-0					1.0E+04	1.5E+04		6.2E+03
				5.0E-02	I					1	0.1		1.4E+09		Chlorsulfuron	64902-72-3					5.1E+04	7.7E+04		3.1E+04
				8.0E-04	H					1	0.1		1.4E+09		Chlorthiophos	60238-56-4					8.2E+02	1.2E+03		4.9E+02
				1.5E+00	I					0.013			1.4E+09		Chromium(III), Insoluble Salts	16065-83-1					1.5E+06			1.5E+06
5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I		M	0.025			1.4E+09		Chromium(VI)	18540-29-9	5.7E+00		2.0E+02	5.6E+00	3.1E+03		6.0E+05	3.1E+03
										0.013			1.4E+09		Chromium, Total	7440-47-3								
		9.0E-03	P	3.0E-04	P	6.0E-06	P			1			1.4E+09		Cobalt	7440-48-4			1.9E+03	1.9E+03	3.1E+02		3.6E+04	3.0E+02
		6.2E-04	I						M	1	0.1				Coke Oven Emissions	8007-45-2								
				4.0E-02	H					1			1.4E+09		Copper	7440-50-8					4.1E+04			4.1E+04
				5.0E-02	I	6.0E-01	C			1	0.1		1.4E+09		Cresol, m-	108-39-4					5.1E+04	7.7E+04	3.6E+09	3.1E+04
				5.0E-02	I	6.0E-01	C			1	0.1		1.4E+09		Cresol, o-	95-48-7					5.1E+04	7.7E+04	3.6E+09	3.1E+04
				1.0E-01	A	6.0E-01	C			1	0.1		1.4E+09		Cresol, p-	106-44-5					1.0E+05	1.5E+05	3.6E+09	6.2E+04
				1.0E-01	A					1	0.1		1.4E+09		Cresol, p-chloro-m-	59-50-7					1.0E+05	1.5E+05		6.2E+04
				1.0E-01	A	6.0E-01	C			1	0.1		1.4E+09		Cresols	1319-77-3					1.0E+05	1.5E+05	3.6E+09	6.2E+04
1.9E+00	H			1.0E-03	P			V		1		1.7E+04	1.4E+09	2.0E+04	Crotonaldehyde, trans-	123-73-9	1.5E+00			1.5E+00	1.0E+03			1.0E+03
				1.0E-01	I	4.0E-01	I	V		1		2.7E+02	1.4E+09	6.7E+03	Cumene	98-82-8					1.0E+05		1.2E+04	1.1E+04
2.2E-01	C	6.3E-05	C							1	0.1		1.4E+09		Cupferron	135-20-6	1.3E+01	2.0E+01	2.6E+05	7.8E+00				
8.4E-01	H			2.0E-03	H					1	0.1		1.4E+09		Cyanazine	21725-46-2	3.4E+00	5.2E+00		2.1E+00	2.0E+03	3.1E+03		1.2E+03
															Cyanides									
				1.0E-03	I					1			1.4E+09		~Calcium Cyanide	592-01-8					1.0E+03			1.0E+03
				5.0E-03	I					1			1.4E+09		~Copper Cyanide	544-92-3					5.1E+03			5.1E+03
				6.0E-04	I	8.0E-04	S	V		1		1.0E+07	1.4E+09	5.0E+04	~Cyanide (CN-)	57-12-5					6.1E+02		1.8E+02	1.4E+02
				1.0E-03	I			V		1			1.4E+09		~Cyanogen	460-19-5					1.0E+03			1.0E+03
				9.0E-02	I			V		1			1.4E+09		~Cyanogen Bromide	506-68-3					9.2E+04			9.2E+04
				5.0E-02	I			V		1			1.4E+09		~Cyanogen Chloride	506-77-4					5.1E+04			5.1E+04
				6.0E-04	I	8.0E-04	I	V		1		1.0E+07	1.4E+09	5.6E+04	~Hydrogen Cyanide	74-90-8					6.1E+02		2.0E+02	1.5E+02
				2.0E-03	I					1			1.4E+09		~Potassium Cyanide	151-50-8					2.0E+03			2.0E+03
				5.0E-03	I					0.04			1.4E+09		~Potassium Silver Cyanide	506-61-6					5.1E+03			5.1E+03
				1.0E-01	I					0.04			1.4E+09		~Silver Cyanide	506-64-9					1.0E+05			1.0E+05
				1.0E-03	I					1			1.4E+09		~Sodium Cyanide	143-33-9					1.0E+03			1.0E+03
				2.0E-04	P					1			1.4E+09		~Thiocyanates	NA					2.0E+02			2.0E+02
				2.0E-04	X					1			1.4E+09		~Thiocyanic Acid	463-56-9								
				5.0E-02	I					1			1.4E+09		~Zinc Cyanide	557-21-1					5.1E+04			5.1E+04
						6.0E+00	I	V		1		1.2E+02	1.4E+09	1.1E+03	Cyclohexane	110-82-7							2.9E+04	2.9E+04
2.3E-02	H									1	0.1		1.4E+09		Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	1.2E+02	1.9E+02		7.5E+01				
				5.0E+00	I	7.0E-01	P			1	0.1		1.4E+09		Cyclohexanone	108-94-1					5.1E+06	7.7E+06	4.2E+09	3.1E+06
				5.0E-03	P	1.0E+00	X	V		1		2.8E+02	1.4E+09	1.4E+03	Cyclohexene	110-83-8					5.1E+03		6.3E+03	2.8E+03
				2.0E-01	I					1	0.1		1.4E+09		Cyclohexylamine	108-91-8					2.0E+05	3.1E+05		1.2E+05
				5.0E-03	I					1	0.1		1.4E+09		Cyhalothrin/karate	68085-85-8					5.1E+03	7.7E+03		3.1E+03
				1.0E-02	I					1	0.1		1.4E+09		Cypermethrin	52315-07-8					1.0E+04	1.5E+04		6.2E+03
				7.5E-03	I					1	0.1		1.4E+09		Cyromazine	66215-27-8					7.7E+03	1.2E+04		4.6E+03
2.4E-01	I	6.9E-05	C							1	0.1		1.4E+09		DDD	72-54-8	1.2E+01	1.8E+01	2.4E+05	7.2E+00				
3.4E-01	I	9.7E-05	C							1	0.1		1.4E+09		DDE, p,p'-	72-55-9	8.4E+00	1.3E+01	1.7E+05	5.1E+00				
3.4E-01	I	9.7E-05	I	5.0E-04	I					1	0.03		1.4E+09		DDT	50-29-3	8.4E+00	4.3E+01	1.7E+05	7.0E+00	5.1E+02	2.6E+03		4.3E+02

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.0E-02	I					1	0.1		1.4E+09		Dacthal	1861-32-1					1.0E+04	1.5E+04		6.2E+03
				3.0E-02	I					1	0.1		1.4E+09		Dalapon	75-99-0					3.1E+04	4.6E+04		1.8E+04
7.0E-04	I			7.0E-03	I					1	0.1		1.4E+09		Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	4.1E+03	6.2E+03		2.5E+03	7.2E+03	1.1E+04		4.3E+03
				4.0E-05	I					1	0.1		1.4E+09		Demeton	8065-48-3					4.1E+01	6.2E+01		2.5E+01
1.2E-03	I			6.0E-01	I					1	0.1		1.4E+09		Di(2-ethylhexyl)adipate	103-23-1	2.4E+03	3.6E+03		1.4E+03	6.1E+05	9.3E+05		3.7E+05
6.1E-02	H									1	0.1		1.4E+09		Diallate	2303-16-4	4.7E+01	7.1E+01		2.8E+01				
				7.0E-04	A					1	0.1		1.4E+09		Diazinon	333-41-5					7.2E+02	1.1E+03		4.3E+02
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	1		9.8E+02	1.4E+09	3.4E+04	Dibromo-3-chloropropane, 1,2-	96-12-8	3.6E+00		7.0E-02	6.9E-02	2.0E+02		3.0E+01	2.6E+01
				1.0E-02	I					1	0.1		1.4E+09		Dibromobenzene, 1,4-	106-37-6					1.0E+04	1.5E+04		6.2E+03
8.4E-02	I	2.7E-05	C	2.0E-02	I			V		1	0.1	8.0E+02	1.4E+09	8.6E+03	Dibromochloromethane	124-48-1	3.4E+01	5.2E+01	3.9E+00	3.3E+00	2.0E+04	3.1E+04		1.2E+04
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1		1.3E+03	1.4E+09	9.3E+03	Dibromoethane, 1,2-	106-93-4	1.4E+00		1.9E-01	1.7E-01	9.2E+03		3.7E+02	3.5E+02
				1.0E-02	H	4.0E-03	X	V		1		2.8E+03	1.4E+09	6.1E+03	Dibromomethane (Methylene Bromide)	74-95-3					1.0E+04		1.1E+02	1.1E+02
				1.0E-01	I					1	0.1		1.4E+09		Dibutyl Phthalate	84-74-2					1.0E+05	1.5E+05		6.2E+04
				3.0E-04	P					1	0.1		1.4E+09		Dibutyltin Compounds	NA					3.1E+02	4.6E+02		1.8E+02
				3.0E-02	I					1	0.1		1.4E+09		Dicamba	1918-00-9					3.1E+04	4.6E+04		1.8E+04
		4.2E-03	P					V		1		5.2E+02	1.4E+09	1.2E+04	Dichloro-2-butene, 1,4-	764-41-0			3.5E-02	3.5E-02				
		4.2E-03	P					V		1	0.1	5.2E+02	1.4E+09	1.2E+04	Dichloro-2-butene, cis-1,4-	1476-11-5			3.5E-02	3.5E-02				
		4.2E-03	P					V		1	0.1	7.6E+02	1.4E+09	1.2E+04	Dichloro-2-butene, trans-1,4-	110-57-6			3.5E-02	3.5E-02				
5.0E-02	I			4.0E-03	I					1	0.1		1.4E+09		Dichloroacetic Acid	79-43-6	5.7E+01	8.7E+01		3.4E+01	4.1E+03	6.2E+03		2.5E+03
				9.0E-02	I	2.0E-01	H	V		1		3.8E+02	1.4E+09	1.3E+04	Dichlorobenzene, 1,2-	95-50-1					9.2E+04		1.1E+04	9.8E+03
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		1			1.4E+09	1.1E+04	Dichlorobenzene, 1,4-	106-46-7	5.3E+02		1.3E+01	1.2E+01	7.2E+04		3.9E+04	2.5E+04
4.5E-01	I	3.4E-04	C							1	0.1		1.4E+09		Dichlorobenzidine, 3,3'-	91-94-1	6.4E+00	9.6E+00	4.9E+04	3.8E+00				
				9.0E-03	X					1	0.1		1.4E+09		Dichlorobenzophenone, 4,4'-	90-98-2					9.2E+03	1.4E+04		5.5E+03
				2.0E-01	I	1.0E-01	X	V		1		8.5E+02	1.4E+09	9.1E+02	Dichlorodifluoromethane	75-71-8					2.0E+05		4.0E+02	4.0E+02
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1		1.7E+03	1.4E+09	2.2E+03	Dichloroethane, 1,1-	75-34-3	5.0E+02		1.7E+01	1.7E+01	2.0E+05			2.0E+05
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		1		3.0E+03	1.4E+09	4.9E+03	Dichloroethane, 1,2-	107-06-2	3.1E+01		2.3E+00	2.2E+00	6.1E+03		1.5E+02	1.5E+02
				5.0E-02	I	2.0E-01	I	V		1		1.2E+03	1.4E+09	1.2E+03	Dichloroethylene, 1,1-	75-35-4					5.1E+04		1.1E+03	1.1E+03
				9.0E-03	H			V		1		1.3E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0					9.2E+03			9.2E+03
				2.0E-03	I			V		1		2.4E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2-cis-	156-59-2					2.0E+03			2.0E+03
				2.0E-02	I	6.0E-02	P	V		1		1.7E+03	1.4E+09	2.7E+03	Dichloroethylene, 1,2-trans-	156-60-5					2.0E+04		7.1E+02	6.9E+02
				3.0E-03	I					1	0.1		1.4E+09		Dichlorophenol, 2,4-	120-83-2					3.1E+03	4.6E+03		1.8E+03
				1.0E-02	I					1	0.05		1.4E+09		Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					1.0E+04	3.1E+04		7.7E+03
				8.0E-03	I					1	0.1		1.4E+09		Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6					8.2E+03	1.2E+04		4.9E+03
3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		1		1.4E+03	1.4E+09	4.1E+03	Dichloropropane, 1,2-	78-87-5	7.9E+01		5.0E+00	4.7E+00	9.2E+04		7.1E+01	7.1E+01
				2.0E-02	P			V		1		1.5E+03	1.4E+09	7.3E+03	Dichloropropane, 1,3-	142-28-9					2.0E+04			2.0E+04
				3.0E-03	I					1	0.1		1.4E+09		Dichloropropanol, 2,3-	616-23-9					3.1E+03	4.6E+03		1.8E+03
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1		1.6E+03	1.4E+09	3.8E+03	Dichloropropene, 1,3-	542-75-6	2.9E+01		1.2E+01	8.3E+00	3.1E+04		3.4E+02	3.3E+02
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1	0.1		1.4E+09		Dichlorvos	62-73-7	9.9E+00	1.5E+01	2.0E+05	5.9E+00	5.1E+02	7.7E+02	3.0E+06	3.1E+02
				8.0E-03	P	7.0E-03	P	V		1			1.4E+09	4.4E+03	Dicyclopentadiene	77-73-6					8.2E+03		1.4E+02	1.3E+02
1.6E+01	I	4.6E-03	I	5.0E-05	I					1	0.1		1.4E+09		Dieldrin	60-57-1	1.8E-01	2.7E-01	3.6E+03	1.1E-01	5.1E+01	7.7E+01		3.1E+01
		3.0E-04	C			5.0E-03	I			1	0.1				Diesel Engine Exhaust	NA								
				2.0E-03	P	2.0E-04	P			1	0.1		1.4E+09		Diethanolamine	111-42-2					2.0E+03	3.1E+03	1.2E+06	1.2E+03
				8.0E-01	I					1	0.1		1.4E+09		Diethyl Phthalate	84-66-2					8.2E+05	1.2E+06		4.9E+05
				3.0E-02	P	1.0E-04	P			1	0.1		1.4E+09		Diethylene Glycol Monobutyl Ether	112-34-5					3.1E+04	4.6E+04	6.0E+05	1.8E+04
				6.0E-02	P	3.0E-04	P			1	0.1		1.4E+09		Diethylene Glycol Monoethyl Ether	111-90-0					6.1E+04	9.3E+04	1.8E+06	3.6E+04
				1.0E-03	P					1	0.1		1.4E+09		Diethylformamide	617-84-5					1.0E+03	1.5E+03		6.2E+02
3.5E+02	C	1.0E-01	C							1	0.1		1.4E+09		Diethylstilbestrol	56-53-1	8.2E-03	1.2E-02	1.7E+02	4.9E-03				
				8.0E-02	I					1	0.1		1.4E+09		Difenzoquat	43222-48-6					8.2E+04	1.2E+05		4.9E+04
				2.0E-02	I					1	0.1		1.4E+09		Diflubenzuron	35367-38-5					2.0E+04	3.1E+04		1.2E+04
						4.0E+01	I	V		1		1.4E+03	1.4E+09	1.2E+03	Difluoroethane, 1,1-	75-37-6							2.2E+05	2.2E+05
4.4E-02	C	1.3E-05	C					V		1	0.1		1.4E+09	1.3E+03	Dihydrosafrole	94-58-6	6.5E+01	9.9E+01	1.3E+00	1.2E+00				
						7.0E-01	P	V		1		2.3E+03	1.4E+09	3.3E+03	Diisopropyl Ether	108-20-3							1.0E+04	1.0E+04
				8.0E-02	I			V		1		5.3E+02	1.4E+09	3.1E+04	Diisopropyl Methylphosphonate	1445-75-6					8.2E+04			8.2E+04
				2.0E-02	I					1	0.1		1.4E+09		Dimethipin	55290-64-7					2.0E+04	3.1E+04		1.2E+04
				2.0E-04	I					1	0.1		1.4E+09		Dimethoate	60-51-5					2.0E+02	3.1E+02		1.2E+02
1.4E-02	H									1	0.1		1.4E+09		Dimethoxybenzidine, 3,3'-	119-90-4	2.0E+02	3.1E+02		1.2E+02				
1.7E-03	P			6.0E-02	P					1	0.1		1.4E+09		Dimethyl methylphosphonate	756-79-6	1.7E+03	2.6E+03		1.0E+03	6.1E+04	9.3E+04		3.7E+04
4.6E+00	C	1.3E-03	C							1	0.1		1.4E+09		Dimethylamino azobenzene [p-]	60-11-7	6.2E-01	9.4E-01	1.3E+04	3.7E-01				
5.8E-01	H									1	0.1		1.4E+09		Dimethylaniline HCl, 2,4-	21436-96-4	4.9E+00	7.5E+00		3.0E+00				
2.0E-01	P			2.0E-03	X					1	0.1		1.4E+09		Dimethylaniline, 2,4-	95-68-1	1.4E+01	2.2E+01		8.6E+00	2.0E+03	3.1E+03		1.2E+03
				2.0E-03	I			V		1		8.3E+02	1.4E+09	3.4E+04	Dimethylaniline, N,N-	121-69-7					2.0E+03			2.0E+03
1.1E+01	P									1	0.1		1.4E+09		Dimethylbenzidine, 3,3'-	119-93-7	2.6E-01	3.9E-01		1.6E-01				
				1.0E-01	P	3.0E-02	I			1	0.1		1.4E+09		Dimethylformamide	68-12-2					1.0E+05	1.5E+05	1.8E+08	6.2E+04
				1.0E-04	X	2.0E-06	X			1	0.1		1.4E+09		Dimethylhydrazine, 1,1-	57-14-7					1.0E+02	1.5E+02	1.2E+04	6.1E+01
5.5E+02	C	1.6E-01	C							1	0.1		1.4E+09		Dimethylhydrazine, 1,2-	540-73-8	5.2E-03	7.9E-03	1.0E+02	3.1E-03				

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vo c	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-02	I					1	0.1		1.4E+09		Dimethylphenol, 2,4-	105-67-9					2.0E+04	3.1E+04		1.2E+04
				6.0E-04	I					1	0.1		1.4E+09		Dimethylphenol, 2,6-	576-26-1					6.1E+02	9.3E+02		3.7E+02
				1.0E-03	I					1	0.1		1.4E+09		Dimethylphenol, 3,4-	95-65-8					1.0E+03	1.5E+03		6.2E+02
				1.0E-01	I			V		1			1.4E+09	2.3E+04	Dimethylterephthalate	120-61-6					1.0E+05			1.0E+05
4.5E-02	C	1.3E-05	C					V		1	0.1	1.1E+03	1.4E+09	1.1E+03	Dimethylvinylchloride	513-37-1	6.4E+01	9.6E+01	1.0E+00	1.0E+00				
				8.0E-05	X					1	0.1		1.4E+09		Dinitro-o-cresol, 4,6-	534-52-1					8.2E+01	1.2E+02		4.9E+01
				2.0E-03	I					1	0.1		1.4E+09		Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					2.0E+03	3.1E+03		1.2E+03
				1.0E-04	P					1	0.1		1.4E+09		Dinitrobenzene, 1,2-	528-29-0					1.0E+02	1.5E+02		6.2E+01
				1.0E-04	I					1	0.1		1.4E+09		Dinitrobenzene, 1,3-	99-65-0					1.0E+02	1.5E+02		6.2E+01
				1.0E-04	P					1	0.1		1.4E+09		Dinitrobenzene, 1,4-	100-25-4					1.0E+02	1.5E+02		6.2E+01
				2.0E-03	I					1	0.1		1.4E+09		Dinitrophenol, 2,4-	51-28-5					2.0E+03	3.1E+03		1.2E+03
6.8E-01	I									1	0.1		1.4E+09		Dinitrotoluene Mixture, 2,4/2,6-	NA	4.2E+00	6.4E+00		2.5E+00				
3.1E-01	C	8.9E-05	C	2.0E-03	I					1	0.102		1.4E+09		Dinitrotoluene, 2,4-	121-14-2	9.2E+00	1.4E+01	1.9E+05	5.5E+00	2.0E+03	3.0E+03		1.2E+03
1.5E+00	P			3.0E-04	X					1	0.099		1.4E+09		Dinitrotoluene, 2,6-	606-20-2	1.9E+00	2.9E+00		1.2E+00	3.1E+02	4.7E+02		1.9E+02
				2.0E-03	S					1	0.006		1.4E+09		Dinitrotoluene, 2-Amino-4,6-	35572-78-2					2.0E+03	5.2E+04		2.0E+03
				2.0E-03	S					1	0.009		1.4E+09		Dinitrotoluene, 4-Amino-2,6-	19406-51-0					2.0E+03	3.4E+04		1.9E+03
4.5E-01	X			9.0E-04	X					1	0.1		1.4E+09		Dinitrotoluene, Technical grade	25321-14-6	6.4E+00	9.6E+00		3.8E+00	9.2E+02	1.4E+03		5.5E+02
				1.0E-03	I					1	0.1		1.4E+09		Dinoseb	88-85-7					1.0E+03	1.5E+03		6.2E+02
1.0E-01	I	7.7E-06	C	3.0E-02	I	1.1E-01	A			1	0.1		1.4E+09		Dioxane, 1,4-	123-91-1	2.9E+01	4.3E+01	2.2E+06	1.7E+01	3.1E+04	4.6E+04	6.5E+08	1.8E+04
															Dioxins									
6.2E+03	I	1.3E+00	I							1	0.03		1.4E+09		~Hexachlorodibenzo-p-dioxin, Mixture	NA	4.6E-04	2.3E-03	1.3E+01	3.9E-04				
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C			1	0.03		1.4E+09		~TCDD, 2,3,7,8-	1746-01-6	2.2E-05	1.1E-04	4.4E-01	1.8E-05	7.2E-04	3.6E-03	2.4E+02	6.0E-04
				3.0E-02	I					1	0.1		1.4E+09		Diphenamid	957-51-7					3.1E+04	4.6E+04		1.8E+04
				8.0E-04	X					1	0.1		1.4E+09		Diphenyl Sulfone	127-63-9					8.2E+02	1.2E+03		4.9E+02
				2.5E-02	I					1	0.1		1.4E+09		Diphenylamine	122-39-4					2.6E+04	3.9E+04		1.5E+04
8.0E-01	I	2.2E-04	I							1	0.1		1.4E+09		Diphenylhydrazine, 1,2-	122-66-7	3.6E+00	5.4E+00	7.6E+04	2.2E+00				
				2.2E-03	I					1	0.1		1.4E+09		Diquat	85-00-7					2.2E+03	3.4E+03		1.4E+03
7.4E+00	C	2.1E-03	C							1	0.1		1.4E+09		Direct Black 38	1937-37-7	3.9E-01	5.9E-01	7.9E+03	2.3E-01				
7.4E+00	C	2.1E-03	C							1	0.1		1.4E+09		Direct Blue 6	2602-46-2	3.9E-01	5.9E-01	7.9E+03	2.3E-01				
6.7E+00	C	1.9E-03	C							1	0.1		1.4E+09		Direct Brown 95	16071-86-6	4.3E-01	6.5E-01	8.8E+03	2.6E-01				
				4.0E-05	I					1	0.1		1.4E+09		Disulfoton	298-04-4					4.1E+01	6.2E+01		2.5E+01
				1.0E-02	I			V		1	0.1		1.4E+09	4.6E+04	Dithiane, 1,4-	505-29-3					1.0E+04	1.5E+04		6.2E+03
				2.0E-03	I					1	0.1		1.4E+09		Diuron	330-54-1					2.0E+03	3.1E+03		1.2E+03
				4.0E-03	I					1	0.1		1.4E+09		Dodine	2439-10-3					4.1E+03	6.2E+03		2.5E+03
				2.5E-02	I			V		1			1.4E+09	1.3E+05	EPTC	759-94-4					2.6E+04			2.6E+04
				6.0E-03	I					1	0.1		1.4E+09		Endosulfan	115-29-7					6.1E+03	9.3E+03		3.7E+03
				2.0E-02	I					1	0.1		1.4E+09		Endothall	145-73-3					2.0E+04	3.1E+04		1.2E+04
				3.0E-04	I					1	0.1		1.4E+09		Endrin	72-20-8					3.1E+02	4.6E+02		1.8E+02
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1		1.1E+04	1.4E+09	2.0E+04	Epichlorohydrin	106-89-8	2.9E+02		2.1E+02	1.2E+02	6.1E+03		8.9E+01	8.8E+01
						2.0E-02	I	V		1		1.5E+04	1.4E+09	8.2E+03	Epoxybutane, 1,2-	106-88-7							7.2E+02	7.2E+02
				5.0E-03	I					1	0.1		1.4E+09		Ethephon	16672-87-0					5.1E+03	7.7E+03		3.1E+03
				5.0E-04	I					1	0.1		1.4E+09		Ethion	563-12-2					5.1E+02	7.7E+02		3.1E+02
				1.0E-01	P	6.0E-02	P			1	0.1		1.4E+09		Ethoxyethanol Acetate, 2-	111-15-9					1.0E+05	1.5E+05	3.6E+08	6.2E+04
				4.0E-01	H	2.0E-01	I			1	0.1		1.4E+09		Ethoxyethanol, 2-	110-80-5					4.1E+05	6.2E+05	1.2E+09	2.5E+05
				9.0E-01	I			V		1		1.1E+04	1.4E+09	9.3E+03	Ethyl Acetate	141-78-6					9.2E+05			9.2E+05
4.8E-02	H							V		1		2.5E+03	1.4E+09	6.8E+03	Ethyl Acrylate	140-88-5	6.0E+01			6.0E+01				
						1.0E+01	I	V		1		2.1E+03	1.4E+09	1.4E+03	Ethyl Chloride	75-00-3							6.1E+04	6.1E+04
				2.0E-01	I			V		1		1.0E+04	1.4E+09	3.4E+03	Ethyl Ether	60-29-7					2.0E+05			2.0E+05
				9.0E-02	H	3.0E-01	P	V		1		1.1E+03	1.4E+09	6.2E+03	Ethyl Methacrylate	97-63-2					9.2E+04		8.2E+03	7.5E+03
				1.0E-05	I					1	0.1		1.4E+09		Ethyl-p-nitrophenyl Phosphonate	2104-64-5					1.0E+01	1.5E+01		6.2E+00
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		1		4.8E+02	1.4E+09	6.1E+03	Ethylbenzene	100-41-4	2.6E+02		3.0E+01	2.7E+01	1.0E+05		2.7E+04	2.1E+04
				7.0E-02	P					1	0.1		1.4E+09		Ethylene Cyanohydrin	109-78-4					7.2E+04	1.1E+05		4.3E+04
				9.0E-02	P					1	0.1		1.4E+09		Ethylene Diamine	107-15-3					9.2E+04	1.4E+05		5.5E+04
				2.0E+00	I	4.0E-01	C			1	0.1		1.4E+09		Ethylene Glycol	107-21-1					2.0E+06	3.1E+06	2.4E+09	1.2E+06
				1.0E-01	I	1.6E+00	I			1	0.1		1.4E+09		Ethylene Glycol Monobutyl Ether	111-76-2					1.0E+05	1.5E+05	9.5E+09	6.2E+04
3.1E-01	C	8.8E-05	C			3.0E-02	C	V		1		1.2E+05	1.4E+09	6.6E+03	Ethylene Oxide	75-21-8	9.2E+00		9.1E-01	8.3E-01			8.6E+02	8.6E+02
4.5E-02	C	1.3E-05	C	8.0E-05	I					1	0.1		1.4E+09		Ethylene Thiourea	96-45-7	6.4E+01	9.6E+01	1.3E+06	3.8E+01	8.2E+01	1.2E+02		4.9E+01
6.5E+01	C	1.9E-02	C					V		1	0.1	1.5E+05	1.4E+09	2.6E+04	Ethyleneimine	151-56-4	4.4E-02	6.7E-02	1.7E-02	1.0E-02				
				3.0E+00	I					1	0.1		1.4E+09		Ethylphthalyl Ethyl Glycolate	84-72-0					3.1E+06	4.6E+06		1.8E+06
				8.0E-03	I					1	0.1		1.4E+09		Express	101200-48-0					8.2E+03	1.2E+04		4.9E+03
				2.5E-04	I					1	0.1		1.4E+09		Fenamiphos	22224-92-6					2.6E+02	3.9E+02		1.5E+02
				2.5E-02	I					1	0.1		1.4E+09		Fenpropathrin	39515-41-8					2.6E+04	3.9E+04		1.5E+04
				1.3E-02	I					1	0.1		1.4E+09		Fluometuron	2164-17-2					1.3E+04	2.0E+04		8.0E+03
				4.0E-02	C	1.3E-02	C			1			1.4E+09		Fluoride	16984-48-8					4.1E+04		7.7E+07	4.1E+04
				6.0E-02	I	1.3E-02	C			1			1.4E+09		Fluorine (Soluble Fluoride)	7782-41-4					6.1E+04		7.7E+07	6.1E+04

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vo c	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				8.0E-02	I					1	0.1		1.4E+09		Fluridone	59756-60-4					8.2E+04	1.2E+05		4.9E+04
				2.0E-02	I					1	0.1		1.4E+09		Flurprimidol	56425-91-3					2.0E+04	3.1E+04		1.2E+04
				6.0E-02	I					1	0.1		1.4E+09		Flutolanil	66332-96-5					6.1E+04	9.3E+04		3.7E+04
				1.0E-02	I					1	0.1		1.4E+09		Fluvalinate	69409-94-5					1.0E+04	1.5E+04		6.2E+03
3.5E-03	I			1.0E-01	I					1	0.1		1.4E+09		Folpet	133-07-3	8.2E+02	1.2E+03		4.9E+02	1.0E+05	1.5E+05		6.2E+04
1.9E-01	I									1	0.1		1.4E+09		Fomesafen	72178-02-0	1.5E+01	2.3E+01		9.1E+00				
				2.0E-03	I					1	0.1		1.4E+09		Fonofos	944-22-9					2.0E+03	3.1E+03		1.2E+03
		1.3E-05	I	2.0E-01	I	9.8E-03	A			1	0.1		1.4E+09		Formaldehyde	50-00-0			1.3E+06	1.3E+06	2.0E+05	3.1E+05	5.8E+07	1.2E+05
				9.0E-01	P	3.0E-04	X			1	0.1		1.4E+09		Formic Acid	64-18-6					9.2E+05	1.4E+06	1.8E+06	4.2E+05
				3.0E+00	I					1	0.1		1.4E+09		Fosetyl-AL	39148-24-8					3.1E+06	4.6E+06		1.8E+06
															Furans									
				1.0E-03	X			V		1			1.4E+09	2.1E+05	~Dibenzofuran	132-64-9					1.0E+03			1.0E+03
				1.0E-03	I			V		1		6.2E+03	1.4E+09	2.8E+03	~Furan	110-00-9					1.0E+03			1.0E+03
				9.0E-01	I	2.0E+00	I	V		1	0.1	1.7E+05	1.4E+09	1.3E+04	~Tetrahydrofuran	109-99-9					9.2E+05	1.4E+06	1.2E+05	9.5E+04
3.8E+00	H									1	0.1		1.4E+09		Furazolidone	67-45-8	7.5E-01	1.1E+00		4.5E-01				
				3.0E-03	I	5.0E-02	H			1	0.1		1.4E+09		Furfural	98-01-1					3.1E+03	4.6E+03	3.0E+08	1.8E+03
1.5E+00	C	4.3E-04	C							1	0.1		1.4E+09		Furium	531-82-8	1.9E+00	2.9E+00	3.9E+04	1.1E+00				
3.0E-02	I	8.6E-06	C							1	0.1		1.4E+09		Furmecyclox	60568-05-0	9.5E+01	1.4E+02	1.9E+06	5.7E+01				
				4.0E-04	I					1	0.1		1.4E+09		Glufosinate, Ammonium	77182-82-2					4.1E+02	6.2E+02		2.5E+02
						8.0E-05	C			1	0.1		1.4E+09		Glutaraldehyde	111-30-8							4.8E+05	4.8E+05
				4.0E-04	I	1.0E-03	H			1	0.1		1.4E+09		Glycidyl	765-34-4					4.1E+02	6.2E+02	6.0E+06	2.5E+02
				1.0E-01	I					1	0.1		1.4E+09		Glyphosate	1071-83-6					1.0E+05	1.5E+05		6.2E+04
				3.0E-03	I					1	0.1		1.4E+09		Goal	42874-03-3					3.1E+03	4.6E+03		1.8E+03
				3.0E-03	A	1.0E-02	A			1	0.1		1.4E+09		Guthion	86-50-0					3.1E+03	4.6E+03	6.0E+07	1.8E+03
				5.0E-05	I					1	0.1		1.4E+09		Haloxyfop, Methyl	69806-40-2					5.1E+01	7.7E+01		3.1E+01
				1.3E-02	I					1	0.1		1.4E+09		Harmony	79277-27-3					1.3E+04	2.0E+04		8.0E+03
4.5E+00	I	1.3E-03	I	5.0E-04	I					1	0.1		1.4E+09		Heptachlor	76-44-8	6.4E-01	9.6E-01	1.3E+04	3.8E-01	5.1E+02	7.7E+02		3.1E+02
9.1E+00	I	2.6E-03	I	1.3E-05	I					1	0.1		1.4E+09		Heptachlor Epoxide	1024-57-3	3.1E-01	4.8E-01	6.4E+03	1.9E-01	1.3E+01	2.0E+01		8.0E+00
				2.0E-03	I					1	0.1		1.4E+09		Hexabromobenzene	87-82-1					2.0E+03	3.1E+03		1.2E+03
				2.0E-04	I					1	0.1		1.4E+09		Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					2.0E+02	3.1E+02		1.2E+02
1.6E+00	I	4.6E-04	I	8.0E-04	I					1	0.1		1.4E+09		Hexachlorobenzene	118-74-1	1.8E+00	2.7E+00	3.6E+04	1.1E+00	8.2E+02	1.2E+03		4.9E+02
7.8E-02	I	2.2E-05	I	1.0E-03	P					1	0.1		1.4E+09		Hexachlorobutadiene	87-68-3	3.7E+01	5.6E+01	7.6E+05	2.2E+01	1.0E+03	1.5E+03		6.2E+02
6.3E+00	I	1.8E-03	I	8.0E-03	A					1	0.1		1.4E+09		Hexachlorocyclohexane, Alpha-	319-84-6	4.5E-01	6.9E-01	9.3E+03	2.7E-01	8.2E+03	1.2E+04		4.9E+03
1.8E+00	I	5.3E-04	I							1	0.1		1.4E+09		Hexachlorocyclohexane, Beta-	319-85-7	1.6E+00	2.4E+00	3.1E+04	9.6E-01				
1.1E+00	C	3.1E-04	C	3.0E-04	I					1	0.04		1.4E+09		Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	2.6E+00	9.9E+00	5.4E+04	2.1E+00	3.1E+02	1.2E+03		2.4E+02
1.8E+00	I	5.1E-04	I							1	0.1		1.4E+09		Hexachlorocyclohexane, Technical	608-73-1	1.6E+00	2.4E+00	3.3E+04	9.6E-01				
				6.0E-03	I	2.0E-04	I			1	0.1		1.4E+09		Hexachlorocyclopentadiene	77-47-4					6.1E+03	9.3E+03	1.2E+06	3.7E+03
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I			1	0.1		1.4E+09		Hexachloroethane	67-72-1	7.2E+01	1.1E+02	1.5E+06	4.3E+01	7.2E+02	1.1E+03	1.8E+08	4.3E+02
				3.0E-04	I					1	0.1		1.4E+09		Hexachlorophene	70-30-4					3.1E+02	4.6E+02		1.8E+02
1.1E-01	I			3.0E-03	I					1	0.015		1.4E+09		Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	2.6E+01	2.6E+02		2.4E+01	3.1E+03	3.1E+04		2.8E+03
						1.0E-05	I	V		1		5.2E+03	1.4E+09	3.2E+05	Hexamethylene Diisocyanate, 1,6-	822-06-0							1.4E+01	1.4E+01
				4.0E-04	P					1	0.1		1.4E+09		Hexamethylphosphoramide	680-31-9					4.1E+02	6.2E+02		2.5E+02
				6.0E-02	H	7.0E-01	I	V		1		1.4E+02	1.4E+09	8.9E+02	Hexane, N-	110-54-3					6.1E+04		2.7E+03	2.6E+03
				2.0E+00	P					1	0.1		1.4E+09		Hexanedioic Acid	124-04-9					2.0E+06	3.1E+06		1.2E+06
				5.0E-03	I	3.0E-02	I	V		1		3.3E+03	1.4E+09	1.4E+04	Hexanone, 2-	591-78-6					5.1E+03		1.9E+03	1.4E+03
				3.3E-02	I					1	0.1		1.4E+09		Hexazinone	51235-04-2					3.4E+04	5.1E+04		2.0E+04
3.0E+00	I	4.9E-03	I			3.0E-05	P			1			1.4E+09		Hydrazine	302-01-2	9.5E-01		3.4E+03	9.5E-01			1.8E+05	1.8E+05
3.0E+00	I	4.9E-03	I							1			1.4E+09		Hydrazine Sulfate	10034-93-2	9.5E-01		3.4E+03	9.5E-01				
						2.0E-02	I			1			1.4E+09		Hydrogen Chloride	7647-01-0							1.2E+08	1.2E+08
				4.0E-02	C	1.4E-02	C			1			1.4E+09		Hydrogen Fluoride	7664-39-3					4.1E+04		8.3E+07	4.1E+04
						2.0E-03	I			1			1.4E+09		Hydrogen Sulfide	7783-06-4							1.2E+07	1.2E+07
6.0E-02	P			4.0E-02	P					1	0.1		1.4E+09		Hydroquinone	123-31-9	4.8E+01	7.2E+01		2.9E+01	4.1E+04	6.2E+04		2.5E+04
				1.3E-02	I					1	0.1		1.4E+09		Imazalil	35554-44-0					1.3E+04	2.0E+04		8.0E+03
				2.5E-01	I					1	0.1		1.4E+09		Imazaquin	81335-37-7					2.6E+05	3.9E+05		1.5E+05
				1.0E-02	A					1			1.4E+09		Iodine	7553-56-2					1.0E+04			1.0E+04
				4.0E-02	I					1	0.1		1.4E+09		Iprodione	36734-19-7					4.1E+04	6.2E+04		2.5E+04
				7.0E-01	P					1			1.4E+09		Iron	7439-89-6					7.2E+05			7.2E+05
				3.0E-01	I					1	0.1		1.4E+09		Isobutyl Alcohol	78-83-1					3.1E+05	4.6E+05		1.8E+05
9.5E-04	I			2.0E-01	I	2.0E+00	C			1	0.1		1.4E+09		Isophorone	78-59-1	3.0E+03	4.6E+03		1.8E+03	2.0E+05	3.1E+05	1.2E+10	1.2E+05
				1.5E-02	I					1	0.1		1.4E+09		Isopropalin	33820-53-0					1.5E+04	2.3E+04		9.2E+03
						7.0E+00	C			1	0.1		1.4E+09		Isopropanol	67-63-0							4.2E+10	4.2E+10
				1.0E-01	I					1	0.1		1.4E+09		Isopropyl Methyl Phosphonic Acid	1832-54-8					1.0E+05	1.5E+05		6.2E+04
				5.0E-02	I					1	0.1		1.4E+09		Isoxaben	82558-50-7					5.1E+04	7.7E+04		3.1E+04
						3.0E-01	A	V		1			1.4E+09		JP-7	NA							1.8E+09	1.8E+09
				7.5E-02	I					1	0.1		1.4E+09		Kerb	23950-58-5					7.7E+04	1.2E+05		4.6E+04

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				2.0E-03	I					1	0.1		1.4E+09		Lactofen	77501-63-4					2.0E+03	3.1E+03		1.2E+03
															Lead Compounds									
2.8E-01	C	8.0E-05	C							1	0.1		1.4E+09		~Lead acetate	301-04-2	1.0E+01	1.5E+01	2.1E+05	6.2E+00				
										1			1.4E+09		~Lead and Compounds	7439-92-1								8.0E+02
3.8E-02	C	1.1E-05	C							1	0.1		1.4E+09		~Lead subacetate	1335-32-6	7.5E+01	1.1E+02	1.5E+06	4.5E+01				
				1.0E-07	I					1	0.1		1.4E+09		~Tetraethyl Lead	78-00-2					1.0E-01	1.5E-01		6.2E-02
				2.0E-03	I					1	0.1		1.4E+09		Linuron	330-55-2					2.0E+03	3.1E+03		1.2E+03
				2.0E-03	P					1			1.4E+09		Lithium	7439-93-2					2.0E+03			2.0E+03
				2.0E-01	I					1	0.1		1.4E+09		Londax	83055-99-6					2.0E+05	3.1E+05		1.2E+05
				5.0E-04	I					1	0.1		1.4E+09		MCPA	94-74-6					5.1E+02	7.7E+02		3.1E+02
				1.0E-02	I					1	0.1		1.4E+09		MCPB	94-81-5					1.0E+04	1.5E+04		6.2E+03
				1.0E-03	I					1	0.1		1.4E+09		MCPP	93-65-2					1.0E+03	1.5E+03		6.2E+02
				2.0E-02	I					1	0.1		1.4E+09		Malathion	121-75-5					2.0E+04	3.1E+04		1.2E+04
				1.0E-01	I	7.0E-04	C			1	0.1		1.4E+09		Maleic Anhydride	108-31-6					1.0E+05	1.5E+05	4.2E+06	6.1E+04
				5.0E-01	I					1	0.1		1.4E+09		Maleic Hydrazide	123-33-1					5.1E+05	7.7E+05		3.1E+05
				1.0E-04	P					1	0.1		1.4E+09		Malononitrile	109-77-3					1.0E+02	1.5E+02		6.2E+01
				3.0E-02	H					1	0.1		1.4E+09		Mancozeb	8018-01-7					3.1E+04	4.6E+04		1.8E+04
				5.0E-03	I					1	0.1		1.4E+09		Maneb	12427-38-2					5.1E+03	7.7E+03		3.1E+03
				1.4E-01	I	5.0E-05	I			1					Manganese (Diet)	7439-96-5								
				2.4E-02	S	5.0E-05	I			0.04			1.4E+09		Manganese (Non-diet)	7439-96-5					2.5E+04		3.0E+05	2.3E+04
				9.0E-05	H					1	0.1		1.4E+09		Mephosfolan	950-10-7					9.2E+01	1.4E+02		5.5E+01
				3.0E-02	I					1	0.1		1.4E+09		Mepiquat Chloride	24307-26-4					3.1E+04	4.6E+04		1.8E+04
															Mercury Compounds									
				3.0E-04	I	3.0E-04	S			0.07			1.4E+09		~Mercuric Chloride (and other Mercury salts)	7487-94-7					3.1E+02		1.8E+06	3.1E+02
						3.0E-04	I	V		1		3.1E+00	1.4E+09	3.2E+04	~Mercury (elemental)	7439-97-6							4.3E+01	4.3E+01
				1.0E-04	I					1			1.4E+09		~Methyl Mercury	22967-92-6					1.0E+02			1.0E+02
				8.0E-05	I					1	0.1		1.4E+09		~Phenylmercuric Acetate	62-38-4					8.2E+01	1.2E+02		4.9E+01
				3.0E-05	I					1	0.1		1.4E+09		Merphos	150-50-5					3.1E+01	4.6E+01		1.8E+01
				3.0E-05	I					1	0.1		1.4E+09		Merphos Oxide	78-48-8					3.1E+01	4.6E+01		1.8E+01
				6.0E-02	I					1	0.1		1.4E+09		Metalaxyl	57837-19-1					6.1E+04	9.3E+04		3.7E+04
				1.0E-04	I	3.0E-02	P	V		1		4.6E+03	1.4E+09	7.3E+03	Methacrylonitrile	126-98-7					1.0E+02		9.6E+02	9.2E+01
				5.0E-05	I					1	0.1		1.4E+09		Methamidophos	10265-92-6					5.1E+01	7.7E+01		3.1E+01
				5.0E-01	I	4.0E+00	C			1	0.1		1.4E+09		Methanol	67-56-1					5.1E+05	7.7E+05	2.4E+10	3.1E+05
				1.0E-03	I					1	0.1		1.4E+09		Methidathion	950-37-8					1.0E+03	1.5E+03		6.2E+02
				2.5E-02	I					1	0.1		1.4E+09		Methomyl	16752-77-5					2.6E+04	3.9E+04		1.5E+04
4.9E-02	C	1.4E-05	C							1	0.1		1.4E+09		Methoxy-5-nitroaniline, 2-	99-59-2	5.8E+01	8.8E+01	1.2E+06	3.5E+01				
				5.0E-03	I					1	0.1		1.4E+09		Methoxychlor	72-43-5					5.1E+03	7.7E+03		3.1E+03
				8.0E-03	P	1.0E-03	P			1	0.1		1.4E+09		Methoxyethanol Acetate, 2-	110-49-6					8.2E+03	1.2E+04	6.0E+06	4.9E+03
				5.0E-03	P	2.0E-02	I			1	0.1		1.4E+09		Methoxyethanol, 2-	109-86-4					5.1E+03	7.7E+03	1.2E+08	3.1E+03
				1.0E+00	X			V		1		2.9E+04	1.4E+09	8.7E+03	Methyl Acetate	79-20-9					1.0E+06			1.0E+06
				3.0E-02	H	2.0E-02	P	V		1		6.8E+03	1.4E+09	7.5E+03	Methyl Acrylate	96-33-3					3.1E+04		6.6E+02	6.4E+02
				6.0E-01	I	5.0E+00	I	V		1		2.8E+04	1.4E+09	1.3E+04	Methyl Ethyl Ketone (2-Butanone)	78-93-3					6.1E+05		2.9E+05	2.0E+05
		1.0E-03	X	1.0E-03	P	2.0E-05	X			1	0.1		1.4E+09		Methyl Hydrazine	60-34-4			1.7E+04	1.7E+04	1.0E+03	1.5E+03	1.2E+05	6.1E+02
				8.0E-02	H	3.0E+00	I	V		1		3.4E+03	1.4E+09	1.1E+04	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1					8.2E+04		1.5E+05	5.3E+04
						1.0E-03	C	V		1	0.1	1.7E+04	1.4E+09	4.8E+03	Methyl Isocyanate	624-83-9							2.1E+01	2.1E+01
				1.4E+00	I	7.0E-01	I	V		1		2.4E+03	1.4E+09	6.8E+03	Methyl Methacrylate	80-62-6					1.4E+06		2.1E+04	2.1E+04
				2.5E-04	I					1	0.1		1.4E+09		Methyl Parathion	298-00-0					2.6E+02	3.9E+02		1.5E+02
				6.0E-02	X					1	0.1		1.4E+09		Methyl Phosphonic Acid	993-13-5					6.1E+04	9.3E+04		3.7E+04
				6.0E-03	H	4.0E-02	H	V		1		3.9E+02	1.4E+09	1.2E+04	Methyl Styrene (Mixed Isomers)	25013-15-4					6.1E+03		2.0E+03	1.5E+03
9.9E-02	C	2.8E-05	C							1	0.1		1.4E+09		Methyl methanesulfonate	66-27-3	2.9E+01	4.4E+01	6.0E+05	1.7E+01				
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		1		8.9E+03	1.4E+09	5.3E+03	Methyl tert-Butyl Ether (MTBE)	1634-04-4	1.6E+03		2.5E+02	2.2E+02			6.9E+04	6.9E+04
				3.0E-04	X					1	0.1		1.4E+09		Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					3.1E+02	4.6E+02		1.8E+02
9.0E-03	P			2.0E-02	X					1	0.1		1.4E+09		Methyl-5-Nitroaniline, 2-	99-55-8	3.2E+02	4.8E+02		1.9E+02	2.0E+04	3.1E+04		1.2E+04
8.3E+00	C	2.4E-03	C							1	0.1		1.4E+09		Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	3.4E-01	5.2E-01	6.9E+03	2.1E-01				
1.3E-01	C	3.7E-05	C							1	0.1		1.4E+09		Methylaniline Hydrochloride, 2-	636-21-5	2.2E+01	3.3E+01	4.5E+05	1.3E+01				
				1.0E-02	A					1	0.1		1.4E+09		Methylarsonic acid	124-58-3					1.0E+04	1.5E+04		6.2E+03
				2.0E-04	X					1	0.1		1.4E+09		Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					2.0E+02	3.1E+02		1.2E+02
1.0E-01	X			3.0E-04	X					1	0.1		1.4E+09		Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	2.9E+01	4.3E+01		1.7E+01	3.1E+02	4.6E+02		1.8E+02
2.2E+01	C	6.3E-03	C						M	1	0.1		1.4E+09		Methylcholanthrene, 3-	56-49-5	1.3E-01	2.0E-01	2.6E+03	7.8E-02				
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	1		3.3E+03	1.4E+09	2.4E+03	Methylene Chloride	75-09-2	1.4E+03		2.9E+03	9.6E+02	6.1E+03		6.2E+03	3.1E+03
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	1	0.1		1.4E+09		Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.9E+01	4.3E+01	3.9E+04	1.7E+01	2.0E+03	3.1E+03		1.2E+03
4.6E-02	I	1.3E-05	C							1	0.1		1.4E+09		Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	6.2E+01	9.4E+01	1.3E+06	3.7E+01				
1.6E+00	C	4.6E-04	C			2.0E-02	C			1	0.1		1.4E+09		Methylenebisbenzenamine, 4,4'-	101-77-9	1.8E+00	2.7E+00	3.6E+04	1.1E+00			1.2E+08	1.2E+08
						6.0E-04	I			1	0.1		1.4E+09		Methylenediphenyl Diisocyanate	101-68-8							3.6E+06	3.6E+06
				7.0E-02	H			V		1		5.0E+02	1.4E+09	1.4E+04	Methylstyrene, Alpha-	98-83-9					7.2E+04			7.2E+04

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.5E-01	I					1	0.1		1.4E+09		Metolachlor	51218-45-2					1.5E+05	2.3E+05		9.2E+04
				2.5E-02	I					1	0.1		1.4E+09		Metribuzin	21087-64-9					2.6E+04	3.9E+04		1.5E+04
				3.0E+00	P			V		1	0.1	3.4E-01	1.4E+09	1.1E+03	Mineral oils	8012-95-1					3.1E+06	4.6E+06		1.8E+06
1.8E+01	C	5.1E-03	C	2.0E-04	I					1	0.1		1.4E+09		Mirex	2385-85-5	1.6E-01	2.4E-01	3.3E+03	9.6E-02	2.0E+02	3.1E+02		1.2E+02
				2.0E-03	I					1	0.1		1.4E+09		Molinate	2212-67-1					2.0E+03	3.1E+03		1.2E+03
				5.0E-03	I					1			1.4E+09		Molybdenum	7439-98-7					5.1E+03			5.1E+03
				1.0E-01	I					1			1.4E+09		Monochloramine	10599-90-3					1.0E+05			1.0E+05
				2.0E-03	P					1	0.1		1.4E+09		Monomethylaniline	100-61-8					2.0E+03	3.1E+03		1.2E+03
				3.0E-04	X					1	0.1		1.4E+09		N,N'-Diphenyl-1,4-benzenediamine	74-31-7					3.1E+02	4.6E+02		1.8E+02
				2.0E-03	I					1	0.1		1.4E+09		Naled	300-76-5					2.0E+03	3.1E+03		1.2E+03
				3.0E-02	X	1.0E-01	P	V		1			1.4E+09		Naphtha, High Flash Aromatic (HFAN)	64724-95-6					3.1E+04		6.0E+08	3.1E+04
1.8E+00	C	0.0E+00	C							1	0.1		1.4E+09		Naphthylamine, 2-	91-59-8	1.6E+00	2.4E+00		9.6E-01				
				1.0E-01	I					1	0.1		1.4E+09		Napropamide	15299-99-7					1.0E+05	1.5E+05		6.2E+04
				1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Carbonyl	13463-39-3					1.1E+04		8.3E+04	9.9E+03
				1.1E-02	C	2.0E-05	C			1			1.4E+09		Nickel Oxide	1313-99-1					1.1E+04		1.2E+05	1.0E+04
		2.4E-04	I	1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Refinery Dust	NA			6.9E+04	6.9E+04	1.1E+04		8.3E+04	9.9E+03
		2.6E-04	C	2.0E-02	I	9.0E-05	A			0.04			1.4E+09		Nickel Soluble Salts	7440-02-0			6.4E+04	6.4E+04	2.0E+04		5.4E+05	2.0E+04
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C			0.04			1.4E+09		Nickel Subsulfide	12035-72-2	1.7E+00		3.5E+04	1.7E+00	1.1E+04		8.3E+04	9.9E+03
				1.6E+00	I					1			1.4E+09		Nitrate	14797-55-8					1.6E+06			1.6E+06
										1			1.4E+09		Nitrate + Nitrite (as N)	NA								
				1.0E-01	I					1			1.4E+09		Nitrite	14797-65-0					1.0E+05			1.0E+05
				1.0E-02	X	5.0E-05	X			1	0.1		1.4E+09		Nitroaniline, 2-	88-74-4					1.0E+04	1.5E+04	3.0E+05	6.0E+03
2.0E-02	P			4.0E-03	P	6.0E-03	P			1	0.1		1.4E+09		Nitroaniline, 4-	100-01-6	1.4E+02	2.2E+02		8.6E+01	4.1E+03	6.2E+03	3.6E+07	2.5E+03
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		1		3.1E+03	1.4E+09	7.9E+04	Nitrobenzene	98-95-3			2.4E+01	2.4E+01	2.0E+03		3.1E+03	1.2E+03
				3.0E+03	P					1	0.1		1.4E+09		Nitrocellulose	9004-70-0					3.1E+09	4.6E+09		1.8E+09
				7.0E-02	H					1	0.1		1.4E+09		Nitrofurantoin	67-20-9					7.2E+04	1.1E+05		4.3E+04
1.3E+00	C	3.7E-04	C							1	0.1		1.4E+09		Nitrofurazone	59-87-0	2.2E+00	3.3E+00	4.5E+04	1.3E+00				
1.7E-02	P			1.0E-04	P					1	0.1		1.4E+09		Nitroglycerin	55-63-0	1.7E+02	2.6E+02		1.0E+02	1.0E+02	1.5E+02		6.2E+01
				1.0E-01	I					1	0.1		1.4E+09		Nitroguanidine	556-88-7					1.0E+05	1.5E+05		6.2E+04
		9.0E-06	P			2.0E-02	P	V		1		1.8E+04	1.4E+09	1.8E+04	Nitromethane	75-52-5			2.5E+01	2.5E+01			1.6E+03	1.6E+03
		2.7E-03	H			2.0E-02	I	V		1		4.9E+03	1.4E+09	1.4E+04	Nitropropane, 2-	79-46-9			6.4E-02	6.4E-02			1.2E+03	1.2E+03
2.7E+01	C	7.7E-03	C						M	1	0.1		1.4E+09		Nitroso-N-ethylurea, N-	759-73-9	1.1E-01	1.6E-01	2.2E+03	6.4E-02				
1.2E+02	C	3.4E-02	C						M	1	0.1		1.4E+09		Nitroso-N-methylurea, N-	684-93-5	2.4E-02	3.6E-02	4.9E+02	1.4E-02				
5.4E+00	I	1.6E-03	I					V		1			1.4E+09	2.1E+05	Nitroso-di-N-butylamine, N-	924-16-3	5.3E-01		1.6E+00	4.0E-01				
7.0E+00	I	2.0E-03	C							1	0.1		1.4E+09		Nitroso-di-N-propylamine, N-	621-64-7	4.1E-01	6.2E-01	8.3E+03	2.5E-01				
2.8E+00	I	8.0E-04	C							1	0.1		1.4E+09		Nitrosodiethanolamine, N-	1116-54-7	1.0E+00	1.5E+00	2.1E+04	6.2E-01				
1.5E+02	I	4.3E-02	I						M	1	0.1		1.4E+09		Nitrosodiethylamine, N-	55-18-5	1.9E-02	2.9E-02	3.9E+02	1.1E-02				
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	1	0.1		1.4E+09		Nitrosodimethylamine, N-	62-75-9	5.6E-02	8.5E-02	1.2E+03	3.4E-02	8.2E+00	1.2E+01	2.4E+05	4.9E+00
4.9E-03	I	2.6E-06	C							1	0.1		1.4E+09		Nitrosodiphenylamine, N-	86-30-6	5.8E+02	8.8E+02	6.4E+06	3.5E+02				
2.2E+01	I	6.3E-03	C							1	0.1		1.4E+09		Nitrosomethylethylamine, N-	10595-95-6	1.3E-01	2.0E-01	2.6E+03	7.8E-02				
6.7E+00	C	1.9E-03	C							1	0.1		1.4E+09		Nitrosomorpholine [N-]	59-89-2	4.3E-01	6.5E-01	8.8E+03	2.6E-01				
9.4E+00	C	2.7E-03	C							1	0.1		1.4E+09		Nitrosopiperidine [N-]	100-75-4	3.0E-01	4.6E-01	6.2E+03	1.8E-01				
2.1E+00	I	6.1E-04	I							1	0.1		1.4E+09		Nitrosopyrrolidine, N-	930-55-2	1.4E+00	2.1E+00	2.7E+04	8.2E-01				
				1.0E-04	X					1	0.1		1.4E+09		Nitrotoluene, m-	99-08-1					1.0E+02	1.5E+02		6.2E+01
2.2E-01	P			9.0E-04	P			V		1		1.5E+03	1.4E+09	1.5E+05	Nitrotoluene, o-	88-72-2	1.3E+01			1.3E+01	9.2E+02			9.2E+02
1.6E-02	P			4.0E-03	P					1	0.1		1.4E+09		Nitrotoluene, p-	99-99-0	1.8E+02	2.7E+02		1.1E+02	4.1E+03	6.2E+03		2.5E+03
				3.0E-04	X	2.0E-01	P	V		1		6.9E+00	1.4E+09	1.1E+03	Nonane, n-	111-84-2					3.1E+02		9.8E+02	2.3E+02
				4.0E-02	I					1	0.1		1.4E+09		Norflurazon	27314-13-2					4.1E+04	6.2E+04		2.5E+04
				7.0E-04	I					1	0.1		1.4E+09		Nustar	85509-19-9					7.2E+02	1.1E+03		4.3E+02
				3.0E-03	I					1	0.1		1.4E+09		Octabromodiphenyl Ether	32536-52-0					3.1E+03	4.6E+03		1.8E+03
				5.0E-02	I					1	0.006		1.4E+09		Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					5.1E+04	1.3E+06		4.9E+04
				2.0E-03	H					1	0.1		1.4E+09		Octamethylpyrophosphoramide	152-16-9					2.0E+03	3.1E+03		1.2E+03
				1.0E-02	P					1	0.1		1.4E+09		Octyl Phthalate, di-N-	117-84-0					1.0E+04	1.5E+04		6.2E+03
				5.0E-02	I					1	0.1		1.4E+09		Oryzalin	19044-88-3					5.1E+04	7.7E+04		3.1E+04
				5.0E-03	I					1	0.1		1.4E+09		Oxadiazon	19666-30-9					5.1E+03	7.7E+03		3.1E+03
				2.5E-02	I					1	0.1		1.4E+09		Oxamyl	23135-22-0					2.6E+04	3.9E+04		1.5E+04
				1.3E-02	I					1	0.1		1.4E+09		Paclobutrazol	76738-62-0					1.3E+04	2.0E+04		8.0E+03
				4.5E-03	I					1	0.1		1.4E+09		Paraquat Dichloride	1910-42-5					4.6E+03	7.0E+03		2.8E+03
				6.0E-03	H					1	0.1		1.4E+09		Parathion	56-38-2					6.1E+03	9.3E+03		3.7E+03
				5.0E-02	H					1	0.1		1.4E+09		Pebulate	1114-71-2					5.1E+04	7.7E+04		3.1E+04
				4.0E-02	I					1	0.1		1.4E+09		Pendimethalin	40487-42-1					4.1E+04	6.2E+04		2.5E+04
				2.0E-03	I					1	0.1		1.4E+09		Pentabromodiphenyl Ether	32534-81-9					2.0E+03	3.1E+03		1.2E+03
				1.0E-04	I					1	0.1		1.4E+09		Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					1.0E+02	1.5E+02		6.2E+01
				8.0E-04	I					1	0.1		1.4E+09		Pentachlorobenzene	608-93-5					8.2E+02	1.2E+03		4.9E+02
9.0E-02	P									1	0.1		1.4E+09		Pentachloroethane	76-01-7	3.2E+01	4.8E+01		1.9E+01				

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
2.6E-01	H			3.0E-03	I					1	0.1		1.4E+09		Pentachloronitrobenzene	82-68-8	1.1E+01	1.7E+01		6.6E+00	3.1E+03	4.6E+03		1.8E+03
4.0E-01	I	5.1E-06	C	5.0E-03	I					1	0.25		1.4E+09		Pentachlorophenol	87-86-5	7.2E+00	4.3E+00	3.3E+06	2.7E+00	5.1E+03	3.1E+03		1.9E+03
4.0E-03	X			2.0E-03	P					1	0.1		1.4E+09		Pentaerythritol tetranitrate (PETN)	78-11-5	7.2E+02	1.1E+03		4.3E+02	2.0E+03	3.1E+03		1.2E+03
						1.0E+00	P	V		1		3.9E+02	1.4E+09	8.4E+02	Pentane, n-	109-66-0							3.7E+03	3.7E+03
															Perchlorates									
				7.0E-04	I					1			1.4E+09		~Ammonium Perchlorate	7790-98-9					7.2E+02			7.2E+02
				7.0E-04	I					1			1.4E+09		~Lithium Perchlorate	7791-03-9					7.2E+02			7.2E+02
				7.0E-04	I					1			1.4E+09		~Perchlorate and Perchlorate Salts	14797-73-0					7.2E+02			7.2E+02
				7.0E-04	I					1			1.4E+09		~Potassium Perchlorate	7778-74-7					7.2E+02			7.2E+02
				7.0E-04	I					1			1.4E+09		~Sodium Perchlorate	7601-89-0					7.2E+02			7.2E+02
				5.0E-02	I					1	0.1		1.4E+09		Permethrin	52645-53-1					5.1E+04	7.7E+04		3.1E+04
2.2E-03	C	6.3E-07	C							1	0.1		1.4E+09		Phenacetin	62-44-2	1.3E+03	2.0E+03	2.6E+07	7.8E+02				
				2.5E-01	I					1	0.1		1.4E+09		Phenmedipham	13684-63-4					2.6E+05	3.9E+05		1.5E+05
				3.0E-01	I	2.0E-01	C			1	0.1		1.4E+09		Phenol	108-95-2					3.1E+05	4.6E+05	1.2E+09	1.8E+05
				5.0E-04	X					1	0.1		1.4E+09		Phenothiazine	92-84-2					5.1E+02	7.7E+02		3.1E+02
				6.0E-03	I					1	0.1		1.4E+09		Phenylenediamine, m-	108-45-2					6.1E+03	9.3E+03		3.7E+03
4.7E-02	H									1	0.1		1.4E+09		Phenylenediamine, o-	95-54-5	6.1E+01	9.2E+01		3.7E+01				
				1.9E-01	H					1	0.1		1.4E+09		Phenylenediamine, p-	106-50-3					1.9E+05	2.9E+05		1.2E+05
1.9E-03	H									1	0.1		1.4E+09		Phenylphenol, 2-	90-43-7	1.5E+03	2.2E+03		8.9E+02				
				2.0E-04	H					1	0.1		1.4E+09		Phorate	298-02-2					2.0E+02	3.1E+02		1.2E+02
						3.0E-04	I	V		1		1.6E+03	1.4E+09	1.1E+03	Phosgene	75-44-5							1.4E+00	1.4E+00
				2.0E-02	I					1	0.1		1.4E+09		Phosmet	732-11-6					2.0E+04	3.1E+04		1.2E+04
															Phosphates, Inorganic									
				4.9E+01	P					1			1.4E+09		~Aluminum metaphosphate	13776-88-0					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Ammonium polyphosphate	68333-79-9					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Calcium pyrophosphate	7790-76-3					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Diammonium phosphate	7783-28-0					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Dicalcium phosphate	7757-93-9					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Dimagnesium phosphate	7782-75-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Dipotassium phosphate	7758-11-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Disodium phosphate	7558-79-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monoaluminum phosphate	13530-50-2					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monoammonium phosphate	7722-76-1					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monocalcium phosphate	7758-23-8					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monomagnesium phosphate	7757-86-0					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monopotassium phosphate	7778-77-0					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Monosodium phosphate	7558-80-7					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Polyphosphoric acid	8017-16-1					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Potassium tripolyphosphate	13845-36-8					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium acid pyrophosphate	7758-16-9					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (acidic)	7785-88-8					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (anhydrous)	10279-59-1					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium hexametaphosphate	10124-56-8					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium polyphosphate	68915-31-1					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium trimetaphosphate	7785-84-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Sodium tripolyphosphate	7758-29-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Tetrapotassium phosphate	7320-34-5					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Tetrasodium pyrophosphate	7722-88-5					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Tricalcium phosphate	7758-87-4					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Trimagnesium phosphate	7757-87-1					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Tripotassium phosphate	7778-53-2					5.0E+07			5.0E+07
				4.9E+01	P					1			1.4E+09		~Trisodium phosphate	7601-54-9					5.0E+07			5.0E+07
				3.0E-04	I	3.0E-04	I			1			1.4E+09		Phosphine	7803-51-2					3.1E+02		1.8E+06	3.1E+02
				4.9E+01	P	1.0E-02	I			1			1.4E+09		Phosphoric Acid	7664-38-2					5.0E+07		6.0E+07	2.7E+07
				2.0E-05	I					1			1.4E+09		Phosphorus, White	7723-14-0					2.0E+01			2.0E+01
				1.0E+00	H					1	0.1		1.4E+09		Phthalic Acid, P-	100-21-0					1.0E+06	1.5E+06		6.2E+05
				2.0E+00	I	2.0E-02	C			1	0.1		1.4E+09		Phthalic Anhydride	85-44-9					2.0E+06	3.1E+06	1.2E+08	1.2E+06
				7.0E-02	I					1	0.1		1.4E+09		Picloram	1918-02-1					7.2E+04	1.1E+05		4.3E+04
				1.0E-04	X					1	0.1		1.4E+09		Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					1.0E+02	1.5E+02		6.2E+01
				1.0E-02	I					1	0.1		1.4E+09		Pirimiphos, Methyl	29232-93-7					1.0E+04	1.5E+04		6.2E+03
3.0E+01	C	8.6E-03	C	7.0E-06	H					1	0.1		1.4E+09		Polybrominated Biphenyls	59536-65-1	9.5E-02	1.4E-01	1.9E+03	5.7E-02	7.2E+00	1.1E+01		4.3E+00
															Polychlorinated Biphenyls (PCBs)									
7.0E-02	S	2.0E-05	S	7.0E-05	I					1	0.14		1.4E+09		~Aroclor 1016	12674-11-2	4.1E+01	4.4E+01	8.3E+05	2.1E+01	7.2E+01	7.7E+01		3.7E+01

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
2.0E+00	S	5.7E-04	S					V		1	0.14	7.6E+02	1.4E+09	9.2E+04	~Aroclor 1221	11104-28-2	1.4E+00	1.5E+00	2.0E+00	5.4E-01				
2.0E+00	S	5.7E-04	S					V		1	0.14	7.3E+01	1.4E+09	9.2E+04	~Aroclor 1232	11141-16-5	1.4E+00	1.5E+00	2.0E+00	5.4E-01				
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1242	53469-21-9	1.4E+00	1.5E+00	2.9E+04	7.4E-01				
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1248	12672-29-6	1.4E+00	1.5E+00	2.9E+04	7.4E-01				
2.0E+00	S	5.7E-04	S	2.0E-05	I					1	0.14		1.4E+09		~Aroclor 1254	11097-69-1	1.4E+00	1.5E+00	2.9E+04	7.4E-01	2.0E+01	2.2E+01		1.1E+01
2.0E+00	S	5.7E-04	S							1	0.14		1.4E+09		~Aroclor 1260	11096-82-5	1.4E+00	1.5E+00	2.9E+04	7.4E-01				
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E			1	0.14		1.4E+09		~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	7.3E-04	7.9E-04	1.5E+01	3.8E-04	2.4E-02	2.6E-02	7.9E+03	1.2E-02
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	7.3E-01	7.9E-01	1.5E+04	3.8E-01	2.4E+01	2.6E+01	7.9E+06	1.2E+01
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E			1	0.14		1.4E+09		~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	2.2E-04	2.4E-04	4.4E+00	1.1E-04	7.2E-03	7.7E-03	2.4E+03	3.7E-03
2.0E+00	I	5.7E-04	I							1	0.14		1.4E+09		~Polychlorinated Biphenyls (high risk)	1336-36-3	1.4E+00	1.5E+00	2.9E+04	7.4E-01				
4.0E-01	I	1.0E-04	I							1	0.14				~Polychlorinated Biphenyls (low risk)	1336-36-3								
7.0E-02	I	2.0E-05	I							1	0.14				~Polychlorinated Biphenyls (lowest risk)	1336-36-3								
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			1	0.14		1.4E+09		~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	2.2E-01	2.4E-01	4.4E+03	1.1E-01	7.2E+00	7.7E+00	2.4E+06	3.7E+00
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E			1	0.14		1.4E+09		~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	7.3E-02	7.9E-02	1.5E+03	3.8E-02	2.4E+00	2.6E+00	7.9E+05	1.2E+00
						6.0E-04	I			1	0.1		1.4E+09		Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							3.6E+06	3.6E+06
															Polynuclear Aromatic Hydrocarbons (PAHs)									
				6.0E-02	I			V		1	0.13		1.4E+09	1.5E+05	~Acenaphthene	83-32-9					6.1E+04	7.1E+04		3.3E+04
				3.0E-01	I			V		1	0.13		1.4E+09	5.6E+05	~Anthracene	120-12-7					3.1E+05	3.6E+05		1.7E+05
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benz[a]anthracene	56-55-3	3.9E+00	4.6E+00	1.5E+05	2.1E+00				
1.2E+00	C	1.1E-04	C							1	0.13		1.4E+09		~Benzo(j)fluoranthene	205-82-3	2.4E+00	2.8E+00	1.5E+05	1.3E+00				
7.3E+00	I	1.1E-03	C						M	1	0.13		1.4E+09		~Benzo[a]pyrene	50-32-8	3.9E-01	4.6E-01	1.5E+04	2.1E-01				
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benzo[b]fluoranthene	205-99-2	3.9E+00	4.6E+00	1.5E+05	2.1E+00				
7.3E-02	E	1.1E-04	C						M	1	0.13		1.4E+09		~Benzo[k]fluoranthene	207-08-9	3.9E+01	4.6E+01	1.5E+05	2.1E+01				
7.3E-03	E	1.1E-05	C						M	1	0.13		1.4E+09		~Chrysene	218-01-9	3.9E+02	4.6E+02	1.5E+06	2.1E+02				
7.3E+00	E	1.2E-03	C						M	1	0.13		1.4E+09		~Dibenz[a,h]anthracene	53-70-3	3.9E-01	4.6E-01	1.4E+04	2.1E-01				
1.2E+01	C	1.1E-03	C							1	0.13		1.4E+09		~Dibenzo(a,e)pyrene	192-65-4	2.4E-01	2.8E-01	1.5E+04	1.3E-01				
2.5E+02	C	7.1E-02	C						M	1	0.13		1.4E+09		~Dimethylbenz(a)anthracene, 7,12-	57-97-6	1.1E-02	1.3E-02	2.3E+02	6.2E-03				
				4.0E-02	I					1	0.13		1.4E+09		~Fluoranthene	206-44-0					4.1E+04	4.8E+04		2.2E+04
				4.0E-02	I			V		1	0.13		1.4E+09	3.0E+05	~Fluorene	86-73-7					4.1E+04	4.8E+04		2.2E+04
7.3E-01	E	1.1E-04	C						M	1	0.13		1.4E+09		~Indeno[1,2,3-cd]pyrene	193-39-5	3.9E+00	4.6E+00	1.5E+05	2.1E+00				
2.9E-02	P			7.0E-02	A			V		1	0.13		1.4E+09	6.3E+04	~Methylnaphthalene, 1-	90-12-0	9.9E+01	1.2E+02		5.3E+01	7.2E+04	8.3E+04		3.9E+04
				4.0E-03	I			V		1	0.13		1.4E+09	6.2E+04	~Methylnaphthalene, 2-	91-57-6					4.1E+03	4.8E+03		2.2E+03
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		1	0.13		1.4E+09	5.0E+04	~Naphthalene	91-20-3			1.8E+01	1.8E+01	2.0E+04	2.4E+04	6.6E+02	6.2E+02
1.2E+00	C	1.1E-04	C							1	0.13		1.4E+09		~Nitropyrene, 4-	57835-92-4	2.4E+00	2.8E+00	1.5E+05	1.3E+00				
				3.0E-02	I			V		1	0.13		1.4E+09	2.6E+06	~Pyrene	129-00-0					3.1E+04	3.6E+04		1.7E+04
1.5E-01	I			9.0E-03	I					1	0.1		1.4E+09		Prochloraz	67747-09-5	1.9E+01	2.9E+01		1.1E+01	9.2E+03	1.4E+04		5.5E+03
				6.0E-03	H					1	0.1		1.4E+09		Profluralin	26399-36-0					6.1E+03	9.3E+03		3.7E+03
				1.5E-02	I					1	0.1		1.4E+09		Prometon	1610-18-0					1.5E+04	2.3E+04		9.2E+03
				4.0E-03	I					1	0.1		1.4E+09		Prometryn	7287-19-6					4.1E+03	6.2E+03		2.5E+03
				1.3E-02	I					1	0.1		1.4E+09		Propachlor	1918-16-7					1.3E+04	2.0E+04		8.0E+03
				5.0E-03	I					1	0.1		1.4E+09		Propanil	709-98-8					5.1E+03	7.7E+03		3.1E+03
				2.0E-02	I					1	0.1		1.4E+09		Propargite	2312-35-8					2.0E+04	3.1E+04		1.2E+04
				2.0E-03	I					1	0.1		1.4E+09		Propargyl Alcohol	107-19-7					2.0E+03	3.1E+03		1.2E+03
				2.0E-02	I					1	0.1		1.4E+09		Propazine	139-40-2					2.0E+04	3.1E+04		1.2E+04
				2.0E-02	I					1	0.1		1.4E+09		Propham	122-42-9					2.0E+04	3.1E+04		1.2E+04
				1.3E-02	I					1	0.1		1.4E+09		Propiconazole	60207-90-1					1.3E+04	2.0E+04		8.0E+03
						8.0E-03	I	V		1		3.3E+04	1.4E+09	9.6E+03	Propionaldehyde	123-38-6							3.4E+02	3.4E+02
				1.0E-01	X	1.0E+00	X	V		1	0.1	2.6E+02	1.4E+09	7.5E+03	Propyl benzene	103-65-1					1.0E+05	1.5E+05	3.3E+04	2.1E+04
						3.0E+00	C	V		1	0.1	3.5E+02	1.4E+09	7.6E+02	Propylene	115-07-1							1.0E+04	1.0E+04
				2.0E+01	P					1	0.1		1.4E+09		Propylene Glycol	57-55-6					2.0E+07	3.1E+07		1.2E+07
						2.7E-04	A			1	0.1		1.4E+09		Propylene Glycol Dinitrate	6423-43-4							1.6E+06	1.6E+06
				7.0E-01	H					1	0.1		1.4E+09		Propylene Glycol Monoethyl Ether	1569-02-4					7.2E+05	1.1E+06		4.3E+05
				7.0E-01	H	2.0E+00	I			1	0.1		1.4E+09		Propylene Glycol Monomethyl Ether	107-98-2					7.2E+05	1.1E+06	1.2E+10	4.3E+05
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1		7.8E+04	1.4E+09	1.1E+04	Propylene Oxide	75-56-9	1.2E+01		3.7E+01	9.0E+00			1.5E+03	1.5E+03
				2.5E-01	I					1	0.1		1.4E+09		Pursuit	81335-77-5					2.6E+05	3.9E+05		1.5E+05
				2.5E-02	I					1	0.1		1.4E+09		Pydrin	51630-58-1					2.6E+04	3.9E+04		1.5E+04
				1.0E-03	I			V		1		5.3E+05	1.4E+09	6.0E+04	Pyridine	110-86-1					1.0E+03			1.0E+03
				5.0E-04	I					1	0.1		1.4E+09		Quinalphos	13593-03-8					5.1E+02	7.7E+02		3.1E+02

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
3.0E+00	I									1	0.1		1.4E+09		Quinoline	91-22-5	9.5E-01	1.4E+00		5.7E-01				
						3.0E-02	A			1			1.4E+09		Refractory Ceramic Fibers	NA							1.8E+08	1.8E+08
				3.0E-02	I					1	0.1		1.4E+09		Resmethrin	10453-86-8					3.1E+04	4.6E+04		1.8E+04
				5.0E-02	H					1	0.1		1.4E+09		Ronnel	299-84-3					5.1E+04	7.7E+04		3.1E+04
				4.0E-03	I					1	0.1		1.4E+09		Rotenone	83-79-4					4.1E+03	6.2E+03		2.5E+03
2.2E-01	C	6.3E-05	C						M	1	0.1		1.4E+09		Safrole	94-59-7	1.3E+01	2.0E+01	2.6E+05	7.8E+00				
				2.5E-02	I					1	0.1		1.4E+09		Savey	78587-05-0					2.6E+04	3.9E+04		1.5E+04
				5.0E-03	I					1			1.4E+09		Selenious Acid	7783-00-8					5.1E+03			5.1E+03
				5.0E-03	I	2.0E-02	C			1			1.4E+09		Selenium	7782-49-2					5.1E+03		1.2E+08	5.1E+03
				5.0E-03	C	2.0E-02	C			1			1.4E+09		Selenium Sulfide	7446-34-6					5.1E+03		1.2E+08	5.1E+03
				9.0E-02	I					1	0.1		1.4E+09		Sethoxydim	74051-80-2					9.2E+04	1.4E+05		5.5E+04
						3.0E-03	C			1			1.4E+09		Silica (crystalline, respirable)	7631-86-9							1.8E+07	1.8E+07
				5.0E-03	I					0.04			1.4E+09		Silver	7440-22-4					5.1E+03			5.1E+03
1.2E-01	H			5.0E-03	I					1	0.1		1.4E+09		Simazine	122-34-9	2.4E+01	3.6E+01		1.4E+01	5.1E+03	7.7E+03		3.1E+03
				1.3E-02	I					1	0.1		1.4E+09		Sodium Acifluorfen	62476-59-9					1.3E+04	2.0E+04		8.0E+03
				4.0E-03	I					1			1.4E+09		Sodium Azide	26628-22-8					4.1E+03			4.1E+03
2.7E-01	H			3.0E-02	I					1	0.1		1.4E+09		Sodium Diethyldithiocarbamate	148-18-5	1.1E+01	1.6E+01		6.4E+00	3.1E+04	4.6E+04		1.8E+04
				5.0E-02	A	1.3E-02	C			1			1.4E+09		Sodium Fluoride	7681-49-4					5.1E+04		7.7E+07	5.1E+04
				2.0E-05	I					1	0.1		1.4E+09		Sodium Fluoroacetate	62-74-8					2.0E+01	3.1E+01		1.2E+01
				1.0E-03	H					1			1.4E+09		Sodium Metavanadate	13718-26-8					1.0E+03			1.0E+03
2.4E-02	H			3.0E-02	I					1	0.1		1.4E+09		Stirofos (Tetrachlorovinphos)	961-11-5	1.2E+02	1.8E+02		7.2E+01	3.1E+04	4.6E+04		1.8E+04
				6.0E-01	I					1			1.4E+09		Strontium, Stable	7440-24-6					6.1E+05			6.1E+05
				3.0E-04	I					1	0.1		1.4E+09		Strychnine	57-24-9					3.1E+02	4.6E+02		1.8E+02
				2.0E-01	I	1.0E+00	I	V		1		8.7E+02	1.4E+09	1.0E+04	Styrene	100-42-5					2.0E+05		4.4E+04	3.6E+04
				1.0E-03	P	2.0E-03	P			1	0.1		1.4E+09		Sulfolane	126-33-0					1.0E+03	1.5E+03	1.2E+07	6.2E+02
				8.0E-04	P					1	0.1		1.4E+09		Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					8.2E+02	1.2E+03		4.9E+02
						1.0E-03	C			1			1.4E+09		Sulfuric Acid	7664-93-9							6.0E+06	6.0E+06
				2.5E-02	I					1	0.1		1.4E+09		Systhane	88671-89-0					2.6E+04	3.9E+04		1.5E+04
				3.0E-02	H					1	0.1		1.4E+09		TCMTB	21564-17-0					3.1E+04	4.6E+04		1.8E+04
				7.0E-02	I					1	0.1		1.4E+09		Tebuthiuron	34014-18-1					7.2E+04	1.1E+05		4.3E+04
				2.0E-02	H					1	0.1		1.4E+09		Temephos	3383-96-8					2.0E+04	3.1E+04		1.2E+04
				1.3E-02	I					1	0.1		1.4E+09		Terbacil	5902-51-2					1.3E+04	2.0E+04		8.0E+03
				2.5E-05	H					1	0.1		1.4E+09		Terbufos	13071-79-9					2.6E+01	3.9E+01		1.5E+01
				1.0E-03	I					1	0.1		1.4E+09		Terbutryn	886-50-0					1.0E+03	1.5E+03		6.2E+02
				1.0E-04	I					1	0.1		1.4E+09		Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					1.0E+02	1.5E+02		6.2E+01
				3.0E-04	I					1	0.1		1.4E+09		Tetrachlorobenzene, 1,2,4,5-	95-94-3					3.1E+02	4.6E+02		1.8E+02
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		1		6.8E+02	1.4E+09	6.1E+03	Tetrachloroethane, 1,1,1,2-	630-20-6	1.1E+02		1.0E+01	9.3E+00	3.1E+04			3.1E+04
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		1		1.9E+03	1.4E+09	1.6E+04	Tetrachloroethane, 1,1,2,2-	79-34-5	1.4E+01		3.4E+00	2.8E+00	2.0E+04			2.0E+04
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		1		1.7E+02	1.4E+09	2.5E+03	Tetrachloroethylene	127-18-4	1.4E+03		1.2E+02	1.1E+02	6.1E+03		4.4E+02	4.1E+02
				3.0E-02	I					1	0.1		1.4E+09		Tetrachlorophenol, 2,3,4,6-	58-90-2					3.1E+04	4.6E+04		1.8E+04
2.0E+01	H									1	0.1		1.4E+09		Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	1.4E-01	2.2E-01		8.6E-02				
				5.0E-04	I					1	0.1		1.4E+09		Tetraethyl Dithiopyrophosphate	3689-24-5					5.1E+02	7.7E+02		3.1E+02
						8.0E+01	I	V		1		1.1E+03	1.4E+09	1.3E+03	Tetrafluoroethane, 1,1,1,2-	811-97-2							4.6E+05	4.6E+05
				4.0E-03	P					1	0.1		1.4E+09		Tetryl (Trinitrophenylmethylnitramine)	479-45-8					4.1E+03	6.2E+03		2.5E+03
				7.0E-06	X					1			1.4E+09		Thallium (I) Nitrate	10102-45-1					7.2E+00			7.2E+00
				1.0E-05	X					1			1.4E+09		Thallium (Soluble Salts)	7440-28-0					1.0E+01			1.0E+01
				6.0E-06	X					1			1.4E+09		Thallium Acetate	563-68-8					6.1E+00			6.1E+00
				2.0E-05	X					1			1.4E+09		Thallium Carbonate	6533-73-9					2.0E+01			2.0E+01
				6.0E-06	X					1			1.4E+09		Thallium Chloride	7791-12-0					6.1E+00			6.1E+00
				2.0E-05	X					1			1.4E+09		Thallium Sulfate	7446-18-6					2.0E+01			2.0E+01
				1.0E-02	I					1	0.1		1.4E+09		Thiobencarb	28249-77-6					1.0E+04	1.5E+04		6.2E+03
				7.0E-02	X					1	0.008		1.4E+09		Thiodiglycol	111-48-8					7.2E+04	1.4E+06		6.8E+04
				3.0E-04	H					1	0.1		1.4E+09		Thiofanox	39196-18-4					3.1E+02	4.6E+02		1.8E+02
				8.0E-02	I					1	0.1		1.4E+09		Thiophanate, Methyl	23564-05-8					8.2E+04	1.2E+05		4.9E+04
				5.0E-03	I					1	0.1		1.4E+09		Thiram	137-26-8					5.1E+03	7.7E+03		3.1E+03
				6.0E-01	H					1			1.4E+09		Tin	7440-31-5					6.1E+05			6.1E+05
						1.0E-04	A			1			1.4E+09		Titanium Tetrachloride	7550-45-0							6.0E+05	6.0E+05
				8.0E-02	I	5.0E+00	I	V		1		8.2E+02	1.4E+09	4.6E+03	Toluene	108-88-3					8.2E+04		1.0E+05	4.5E+04
1.8E-01	X			2.0E-04	X					1	0.1		1.4E+09		Toluene-2,5-diamine	95-70-5	1.6E+01	2.4E+01		9.6E+00	2.0E+02	3.1E+02		1.2E+02
3.0E-02	P			4.0E-03	X					1	0.1		1.4E+09		Toluidine, p-	106-49-0	9.5E+01	1.4E+02		5.7E+01	4.1E+03	6.2E+03		2.5E+03
1.1E+00	I	3.2E-04	I							1	0.1		1.4E+09		Toxaphene	8001-35-2	2.6E+00	3.9E+00	5.2E+04	1.6E+00				
				7.5E-03	I					1	0.1		1.4E+09		Tralomethrin	66841-25-6					7.7E+03	1.2E+04		4.6E+03
				3.0E-04	A					1	0.1		1.4E+09		Tri-n-butyltin	688-73-3					3.1E+02	4.6E+02		1.8E+02
				8.0E+01	X					1	0.1		1.4E+09		Triacetin	102-76-1					8.2E+07	1.2E+08		4.9E+07
				1.3E-02	I					1	0.1		1.4E+09		Triallate	2303-17-5					1.3E+04	2.0E+04		8.0E+03

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	ABS	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)
				1.0E-02	I					1	0.1		1.4E+09		Triasulfuron	82097-50-5					1.0E+04	1.5E+04		6.2E+03
				5.0E-03	I					1	0.1		1.4E+09		Tribromobenzene, 1,2,4-	615-54-3					5.1E+03	7.7E+03		3.1E+03
9.0E-03	P			1.0E-02	P					1	0.1		1.4E+09		Tributyl Phosphate	126-73-8	3.2E+02	4.8E+02		1.9E+02	1.0E+04	1.5E+04		6.2E+03
				3.0E-04	P					1	0.1		1.4E+09		Tributyltin Compounds	NA					3.1E+02	4.6E+02		1.8E+02
				3.0E-04	I					1	0.1		1.4E+09		Tributyltin Oxide	56-35-9					3.1E+02	4.6E+02		1.8E+02
				3.0E+01	I	3.0E+01	H	V		1		9.1E+02	1.4E+09	1.4E+03	Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					3.1E+07		1.8E+05	1.8E+05
7.0E-02	I			2.0E-02	I					1	0.1		1.4E+09		Trichloroacetic Acid	76-03-9	4.1E+01	6.2E+01		2.5E+01	2.0E+04	3.1E+04		1.2E+04
2.9E-02	H									1	0.1		1.4E+09		Trichloroaniline HCl, 2,4,6-	33663-50-2	9.9E+01	1.5E+02		5.9E+01				
7.0E-03	X			3.0E-05	X					1	0.1		1.4E+09		Trichloroaniline, 2,4,6-	634-93-5	4.1E+02	6.2E+02		2.5E+02	3.1E+01	4.6E+01		1.8E+01
				8.0E-04	X			V		1	0.1		1.4E+09	3.5E+04	Trichlorobenzene, 1,2,3-	87-61-6					8.2E+02	1.2E+03		4.9E+02
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1		4.0E+02	1.4E+09	3.2E+04	Trichlorobenzene, 1,2,4-	120-82-1	9.9E+01			9.9E+01	1.0E+04		2.8E+02	2.7E+02
				2.0E+00	I	5.0E+00	I	V		1		6.4E+02	1.4E+09	1.8E+03	Trichloroethane, 1,1,1-	71-55-6					2.0E+06		3.9E+04	3.8E+04
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1		2.2E+03	1.4E+09	7.8E+03	Trichloroethane, 1,1,2-	79-00-5	5.0E+01		6.0E+00	5.3E+00	4.1E+03		6.8E+00	6.8E+00
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	1		6.9E+02	1.4E+09	2.4E+03	Trichloroethylene	79-01-6	6.2E+01		7.1E+00	6.4E+00	5.1E+02		2.1E+01	2.0E+01
				3.0E-01	I	7.0E-01	H	V		1		1.2E+03	1.4E+09	1.1E+03	Trichlorofluoromethane	75-69-4					3.1E+05		3.4E+03	3.4E+03
				1.0E-01	I					1	0.1		1.4E+09		Trichlorophenol, 2,4,5-	95-95-4					1.0E+05	1.5E+05		6.2E+04
1.1E-02	I	3.1E-06	I	1.0E-03	P					1	0.1		1.4E+09		Trichlorophenol, 2,4,6-	88-06-2	2.6E+02	3.9E+02	5.4E+06	1.6E+02	1.0E+03	1.5E+03		6.2E+02
				1.0E-02	I					1	0.1		1.4E+09		Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					1.0E+04	1.5E+04		6.2E+03
				8.0E-03	I					1	0.1		1.4E+09		Trichlorophenoxypropionic acid, -2,4,5	93-72-1					8.2E+03	1.2E+04		4.9E+03
				5.0E-03	I			V		1		1.3E+03	1.4E+09	1.6E+04	Trichloropropane, 1,1,2-	598-77-6					5.1E+03			5.1E+03
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1		1.4E+03	1.4E+09	1.7E+04	Trichloropropane, 1,2,3-	96-18-4	9.5E-02			9.5E-02	4.1E+03		2.2E+01	2.2E+01
				3.0E-03	X	3.0E-04	P	V		1		4.5E+02	1.4E+09	2.5E+03	Trichloropropene, 1,2,3-	96-19-5					3.1E+03		3.3E+00	3.3E+00
				2.0E-02	A					1	0.1		1.4E+09		Tricresyl Phosphate (TCP)	1330-78-5						3.1E+04		3.1E+04
				3.0E-03	I					1	0.1		1.4E+09		Tridiphane	58138-08-2					3.1E+03	4.6E+03		1.8E+03
						7.0E-03	I	V		1		2.8E+04	1.4E+09	1.7E+04	Triethylamine	121-44-8							5.2E+02	5.2E+02
7.7E-03	I			7.5E-03	I					1	0.1		1.4E+09		Trifluralin	1582-09-8	3.7E+02	5.6E+02		2.2E+02	7.7E+03	1.2E+04		4.6E+03
2.0E-02	P			1.0E-02	P					1	0.1		1.4E+09		Trimethyl Phosphate	512-56-1	1.4E+02	2.2E+02		8.6E+01	1.0E+04	1.5E+04		6.2E+03
						5.0E-03	P	V		1		2.9E+02	1.4E+09	1.0E+04	Trimethylbenzene, 1,2,3-	526-73-8							2.2E+02	2.2E+02
						7.0E-03	P	V		1		2.2E+02	1.4E+09	8.5E+03	Trimethylbenzene, 1,2,4-	95-63-6							2.6E+02	2.6E+02
				1.0E-02	X			V		1		1.8E+02	1.4E+09	7.1E+03	Trimethylbenzene, 1,3,5-	108-67-8					1.0E+04			1.0E+04
				3.0E-02	I					1	0.019		1.4E+09		Trinitrobenzene, 1,3,5-	99-35-4					3.1E+04	2.4E+05		2.7E+04
3.0E-02	I			5.0E-04	I					1	0.032		1.4E+09		Trinitrotoluene, 2,4,6-	118-96-7	9.5E+01	4.5E+02		7.9E+01	5.1E+02	2.4E+03		4.2E+02
				2.0E-02	P					1	0.1		1.4E+09		Triphenylphosphine Oxide	791-28-6					2.0E+04	3.1E+04		1.2E+04
				2.0E-02	A					1	0.1		1.4E+09		Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					2.0E+04	3.1E+04		1.2E+04
				1.0E-02	X					1	0.1		1.4E+09		Tris(1-chloro-2-propyl)phosphate	13674-84-5					1.0E+04	1.5E+04		6.2E+03
2.0E-02	P			7.0E-03	P					1	0.1		1.4E+09		Tris(2-chloroethyl)phosphate	115-96-8	1.4E+02	2.2E+02		8.6E+01	7.2E+03	1.1E+04		4.3E+03
3.2E-03	P			1.0E-01	P					1	0.1		1.4E+09		Tris(2-ethylhexyl)phosphate	78-42-2	8.9E+02	1.4E+03		5.4E+02	1.0E+05	1.5E+05		6.2E+04
				3.0E-03	I	4.0E-05	A			1			1.4E+09		Uranium (Soluble Salts)	NA					3.1E+03		2.4E+05	3.0E+03
1.0E+00	C	2.9E-04	C						M	1	0.1		1.4E+09		Urethane	51-79-6	2.9E+00	4.3E+00	5.7E+04	1.7E+00				
		8.3E-03	P	9.0E-03	I	7.0E-06	P			0.026			1.4E+09		Vanadium Pentoxide	1314-62-1			2.0E+03	2.0E+03	9.2E+03		4.2E+04	7.5E+03
				5.0E-03	S	1.0E-04	A			0.026			1.4E+09		Vanadium and Compounds	7440-62-2					5.2E+03		6.0E+05	5.1E+03
				1.0E-03	I					1	0.1		1.4E+09		Vernolate	1929-77-7					1.0E+03	1.5E+03		6.2E+02
				2.5E-02	I					1	0.1		1.4E+09		Vinclozolin	50471-44-8					2.6E+04	3.9E+04		1.5E+04
				1.0E+00	H	2.0E-01	I	V		1		2.8E+03	1.4E+09	4.7E+03	Vinyl Acetate	108-05-4					1.0E+06		4.1E+03	4.1E+03
		3.2E-05	H			3.0E-03	I	V		1		3.4E+03	1.4E+09	1.5E+03	Vinyl Bromide	593-60-2			5.6E-01	5.6E-01			1.9E+01	1.9E+01
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1		3.9E+03	1.4E+09	1.0E+03	Vinyl Chloride	75-01-4	4.0E+00		2.9E+00	1.7E+00	3.1E+03		4.5E+02	3.9E+02
				3.0E-04	I					1	0.1		1.4E+09		Warfarin	81-81-2					3.1E+02	4.6E+02		1.8E+02
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	1.4E+09	6.0E+03	Xylene, P-	106-42-3					2.0E+05		2.6E+03	2.6E+03
				2.0E-01	S	1.0E-01	S	V		1		3.9E+02	1.4E+09	5.9E+03	Xylene, m-	108-38-3					2.0E+05		2.6E+03	2.5E+03
				2.0E-01	S	1.0E-01	S	V		1		4.3E+02	1.4E+09	7.0E+03	Xylene, o-	95-47-6					2.0E+05		3.0E+03	3.0E+03
				2.0E-01	I	1.0E-01	I	V		1		2.6E+02	1.4E+09	6.3E+03	Xylenes	1330-20-7					2.0E+05		2.7E+03	2.7E+03
				3.0E-04	I					1			1.4E+09		Zinc Phosphide	1314-84-7					3.1E+02			3.1E+02
				3.0E-01	I					1			1.4E+09		Zinc and Compounds	7440-66-6					3.1E+05			3.1E+05
				5.0E-02	I					1	0.1		1.4E+09		Zineb	12122-67-7					5.1E+04	7.7E+04		3.1E+04
				8.0E-05	X					1			1.4E+09		Zirconium	7440-67-7					8.2E+01			8.2E+01

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
5.1E-06	C					ALAR	1596-84-5	4.8E-01	
						Acephate	30560-19-1		
2.2E-06	I	9.0E-03	I	V		Acetaldehyde	75-07-0	1.1E+00	9.4E+00
						Acetochlor	34256-82-1		
		3.1E+01	A	V		Acetone	67-64-1		3.2E+04
		2.0E-03	X	V		Acetone Cyanohydrin	75-86-5		2.1E+00
		6.0E-02	I	V		Acetonitrile	75-05-8		6.3E+01
				V		Acetophenone	98-86-2		
1.3E-03	C					Acetylaminofluorene, 2-	53-96-3	1.9E-03	
		2.0E-05	I	V		Acrolein	107-02-8		2.1E-02
1.0E-04	I	6.0E-03	I		M	Acrylamide	79-06-1	9.6E-03	6.3E+00
		1.0E-03	I			Acrylic Acid	79-10-7		1.0E+00
6.8E-05	I	2.0E-03	I	V		Acrylonitrile	107-13-1	3.6E-02	2.1E+00
		6.0E-03	P			Adiponitrile	111-69-3		6.3E+00
						Alachlor	15972-60-8		
						Aldicarb	116-06-3		
						Aldicarb Sulfone	1646-88-4		
						Aldicarb sulfoxide	1646-87-3		
4.9E-03	I					Aldrin	309-00-2	5.0E-04	
						Ally	74223-64-6		
		1.0E-04	X			Allyl Alcohol	107-18-6		1.0E-01
6.0E-06	C	1.0E-03	I	V		Allyl Chloride	107-05-1	4.1E-01	1.0E+00
		5.0E-03	P			Aluminum	7429-90-5		5.2E+00
						Aluminum Phosphide	20859-73-8		
						Amdro	67485-29-4		
						Ametryn	834-12-8		
6.0E-03	C					Aminobiphenyl, 4-	92-67-1	4.1E-04	
						Aminophenol, m-	591-27-5		
						Aminophenol, p-	123-30-8		
						Amitraz	33089-61-1		
		1.0E-01	I			Ammonia	7664-41-7		1.0E+02
						Ammonium Sulfamate	7773-06-0		
1.6E-06	C	1.0E-03	I			Aniline	62-53-3	1.5E+00	1.0E+00
						Anthraquinone, 9,10-	84-65-1		
						Antimony (metallic)	7440-36-0		
						Antimony Pentoxide	1314-60-9		
						Antimony Potassium Tartrate	11071-15-1		
						Antimony Tetroxide	1332-81-6		
		2.0E-04	I			Antimony Trioxide	1309-64-4		2.1E-01
						Apollo	74115-24-5		
7.1E-06	I					Aramite	140-57-8	3.4E-01	
4.3E-03	I	1.5E-05	C			Arsenic, Inorganic	7440-38-2	5.7E-04	1.6E-02
		5.0E-05	I			Arsine	7784-42-1		5.2E-02
						Assure	76578-14-8		
						Asulam	3337-71-1		
						Atrazine	1912-24-9		
2.5E-04	C					Auramine	492-80-8	9.7E-03	
						Avermectin B1	65195-55-3		
3.1E-05	I			V		Azobenzene	103-33-3	7.8E-02	
		5.0E-04	H			Barium	7440-39-3		5.2E-01
						Baygon	114-26-1		
						Bayleton	43121-43-3		
						Baythroid	68359-37-5		
						Benefin	1861-40-1		
						Benomyl	17804-35-2		
						Bentazon	25057-89-0		
				V		Benzaldehyde	100-52-7		
7.8E-06	I	3.0E-02	I	V		Benzene	71-43-2	3.1E-01	3.1E+01
						Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1		
				V		Benzenethiol	108-98-5		
6.7E-02	I				M	Benzidine	92-87-5	1.4E-05	
						Benzoic Acid	65-85-0		
				V		Benzotrichloride	98-07-7		
						Benzyl Alcohol	100-51-6		
4.9E-05	C	1.0E-03	P	V		Benzyl Chloride	100-44-7	5.0E-02	1.0E+00
2.4E-03	I	2.0E-05	I			Beryllium and compounds	7440-41-7	1.0E-03	2.1E-02
						Bidrin	141-66-2		
						Bifenox	42576-02-3		
						Biphenthrin	82657-04-3		
		4.0E-04	X	V		Biphenyl, 1,1'-	92-52-4		4.2E-01
1.0E-05	H			V		Bis(2-chloro-1-methylethyl) ether	108-60-1	2.4E-01	
						Bis(2-chloroethoxy)methane	111-91-1		
3.3E-04	I			V		Bis(2-chloroethyl)ether	111-44-4	7.4E-03	
2.4E-06	C					Bis(2-ethylhexyl)phthalate	117-81-7	1.0E+00	
6.2E-02	I			V		Bis(chloromethyl)ether	542-88-1	3.9E-05	

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Bisphenol A	80-05-7		
		2.0E-02	H			Boron And Borates Only	7440-42-8		2.1E+01
		2.0E-02	P			Boron Trichloride	10294-34-5		2.1E+01
		1.3E-02	C			Boron Trifluoride	7637-07-2		1.4E+01
						Bromate	15541-45-4		
6.0E-04	X			V		Bromo-2-chloroethane, 1-	107-04-0	4.1E-03	
		6.0E-02	I	V		Bromobenzene	108-86-1		6.3E+01
		4.0E-02	X	V		Bromochloromethane	74-97-5		4.2E+01
3.7E-05	C			V		Bromodichloromethane	75-27-4	6.6E-02	
1.1E-06	I					Bromoform	75-25-2	2.2E+00	
		5.0E-03	I	V		Bromomethane	74-83-9		5.2E+00
						Bromophos	2104-96-3		
						Bromoxynil	1689-84-5		
						Bromoxynil Octanoate	1689-99-2		
3.0E-05	I	2.0E-03	I	V		Butadiene, 1,3-	106-99-0	8.1E-02	2.1E+00
						Butanol, N-	71-36-3		
						Butyl Benzyl Phthlate	85-68-7		
		3.0E+01	P			Butyl alcohol, sec-	78-92-2		3.1E+04
						Butylate	2008-41-5		
5.7E-08	C					Butylated hydroxyanisole	25013-16-5	4.3E+01	
				V		Butylbenzene, n-	104-51-8		
				V		Butylbenzene, sec-	135-98-8		
				V		Butylbenzene, tert-	98-06-6		
						Butylphthalyl Butylglycolate	85-70-1		
						Cacodylic Acid	75-60-5		
1.8E-03	I	1.0E-05	A			Cadmium (Diet)	7440-43-9		
1.8E-03	I	1.0E-05	A			Cadmium (Water)	7440-43-9	1.4E-03	1.0E-02
						Caprolactam	105-60-2		
4.3E-05	C					Captafol	2425-06-1	5.7E-02	
6.6E-07	C					Captan	133-06-2	3.7E+00	
						Carbaryl	63-25-2		
						Carbofuran	1563-66-2		
		7.0E-01	I	V		Carbon Disulfide	75-15-0		7.3E+02
6.0E-06	I	1.0E-01	I	V		Carbon Tetrachloride	56-23-5	4.1E-01	1.0E+02
						Carbosulfan	55285-14-8		
						Carboxin	5234-68-4		
		9.0E-04	I			Ceric oxide	1306-38-3		9.4E-01
						Chloral Hydrate	302-17-0		
						Chloramben	133-90-4		
						Chloranil	118-75-2		
1.0E-04	I	7.0E-04	I			Chlordane	12789-03-6	2.4E-02	7.3E-01
4.6E-03	C					Chlordecone (Kepone)	143-50-0	5.3E-04	
						Chlorfenvinphos	470-90-6		
						Chlorimuron, Ethyl-	90982-32-4		
		1.5E-04	A			Chlorine	7782-50-5		1.5E-01
		2.0E-04	I			Chlorine Dioxide	10049-04-4		2.1E-01
						Chlorite (Sodium Salt)	7758-19-2		
		5.0E+01	I	V		Chloro-1,1-difluoroethane, 1-	75-68-3		5.2E+04
3.0E-04	I	2.0E-02	I	V		Chloro-1,3-butadiene, 2-	126-99-8	8.1E-03	2.1E+01
						Chloro-2-methylaniline HCl, 4-	3165-93-3		
7.7E-05	C					Chloro-2-methylaniline, 4-	95-69-2	3.2E-02	
				V		Chloroacetaldehyde, 2-	107-20-0		
						Chloroacetic Acid	79-11-8		
		3.0E-05	I			Chloroacetophenone, 2-	532-27-4		3.1E-02
						Chloroaniline, p-	106-47-8		
		5.0E-02	P	V		Chlorobenzene	108-90-7		5.2E+01
3.1E-05	C					Chlorobenzilate	510-15-6	7.8E-02	
						Chlorobenzoic Acid, p-	74-11-3		
		3.0E-01	P	V		Chlorobenzotrifluoride, 4-	98-56-6		3.1E+02
				V		Chlorobutane, 1-	109-69-3		
		5.0E+01	I	V		Chlorodifluoromethane	75-45-6		5.2E+04
						Chloroethanol, 2-	107-07-3		
2.3E-05	I	9.8E-02	A	V		Chloroform	67-66-3	1.1E-01	1.0E+02
		9.0E-02	I	V		Chloromethane	74-87-3		9.4E+01
6.9E-04	C			V		Chloromethyl Methyl Ether	107-30-2	3.5E-03	
				V		Chloronaphthalene, Beta-	91-58-7		
		1.0E-05	X			Chloronitrobenzene, o-	88-73-3		1.0E-02
		6.0E-04	P			Chloronitrobenzene, p-	100-00-5		6.3E-01
				V		Chlorophenol, 2-	95-57-8		
		4.0E-04	C	V		Chloropicrin	76-06-2		4.2E-01
8.9E-07	C					Chlorothalonil	1897-45-6	2.7E+00	
				V		Chlorotoluene, o-	95-49-8		
				V		Chlorotoluene, p-	106-43-4		
6.9E-02	C					Chlorozotocin	54749-90-5	3.5E-05	
						Chlorpropham	101-21-3		

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR (ug/m^3)$^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Chlorpyrifos	2921-88-2		
						Chlorpyrifos Methyl	5598-13-0		
						Chlorsulfuron	64902-72-3		
						Chlorthiophos	60238-56-4		
						Chromium(III), Insoluble Salts	16065-83-1		
8.4E-02	S	1.0E-04	I		M	Chromium(VI)	18540-29-9	1.1E-05	1.0E-01
						Chromium, Total	7440-47-3		
9.0E-03	P	6.0E-06	P			Cobalt	7440-48-4	2.7E-04	6.3E-03
6.2E-04	I				M	Coke Oven Emissions	8007-45-2	1.5E-03	
						Copper	7440-50-8		
		6.0E-01	C			Cresol, m-	108-39-4		6.3E+02
		6.0E-01	C			Cresol, o-	95-48-7		6.3E+02
		6.0E-01	C			Cresol, p-	106-44-5		6.3E+02
						Cresol, p-chloro-m-	59-50-7		
		6.0E-01	C			Cresols	1319-77-3		6.3E+02
				V		Crotonaldehyde, trans-	123-73-9		
		4.0E-01	I	V		Cumene	98-82-8		4.2E+02
6.3E-05	C					Cupferron	135-20-6	3.9E-02	
						Cyanazine	21725-46-2		
						Cyanides			
						~Calcium Cyanide	592-01-8		
						~Copper Cyanide	544-92-3		
		8.0E-04	S	V		~Cyanide (CN-)	57-12-5		8.3E-01
				V		~Cyanogen	460-19-5		
				V		~Cyanogen Bromide	506-68-3		
				V		~Cyanogen Chloride	506-77-4		
		8.0E-04	I	V		~Hydrogen Cyanide	74-90-8		8.3E-01
						~Potassium Cyanide	151-50-8		
						~Potassium Silver Cyanide	506-61-6		
						~Silver Cyanide	506-64-9		
						~Sodium Cyanide	143-33-9		
						~Thiocyanates	NA		
						~Thiocyanic Acid	463-56-9		
						~Zinc Cyanide	557-21-1		
		6.0E+00	I	V		Cyclohexane	110-82-7		6.3E+03
						Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3		
		7.0E-01	P			Cyclohexanone	108-94-1		7.3E+02
		1.0E+00	X	V		Cyclohexene	110-83-8		1.0E+03
						Cyclohexylamine	108-91-8		
						Cyhalothrin/karate	68085-85-8		
						Cypermethrin	52315-07-8		
						Cyromazine	66215-27-8		
6.9E-05	C					DDD	72-54-8	3.5E-02	
9.7E-05	C					DDE, p,p'-	72-55-9	2.5E-02	
9.7E-05	I					DDT	50-29-3	2.5E-02	
						Dacthal	1861-32-1		
						Dalapon	75-99-0		
						Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5		
						Demeton	8065-48-3		
						Di(2-ethylhexyl)adipate	103-23-1		
						Diallate	2303-16-4		
						Diazinon	333-41-5		
6.0E-03	P	2.0E-04	I	V	M	Dibromo-3-chloropropane, 1,2-	96-12-8	1.6E-04	2.1E-01
						Dibromobenzene, 1,4-	106-37-6		
2.7E-05	C			V		Dibromochloromethane	124-48-1	9.0E-02	
6.0E-04	I	9.0E-03	I	V		Dibromoethane, 1,2-	106-93-4	4.1E-03	9.4E+00
		4.0E-03	X	V		Dibromomethane (Methylene Bromide)	74-95-3		4.2E+00
						Dibutyl Phthalate	84-74-2		
						Dibutyltin Compounds	NA		
						Dicamba	1918-00-9		
4.2E-03	P			V		Dichloro-2-butene, 1,4-	764-41-0	5.8E-04	
4.2E-03	P			V		Dichloro-2-butene, cis-1,4-	1476-11-5	5.8E-04	
4.2E-03	P			V		Dichloro-2-butene, trans-1,4-	110-57-6	5.8E-04	
						Dichloroacetic Acid	79-43-6		
		2.0E-01	H	V		Dichlorobenzene, 1,2-	95-50-1		2.1E+02
1.1E-05	C	8.0E-01	I	V		Dichlorobenzene, 1,4-	106-46-7	2.2E-01	8.3E+02
3.4E-04	C					Dichlorobenzidine, 3,3'-	91-94-1	7.2E-03	
						Dichlorobenzophenone, 4,4'-	90-98-2		
		1.0E-01	X	V		Dichlorodifluoromethane	75-71-8		1.0E+02
1.6E-06	C			V		Dichloroethane, 1,1-	75-34-3	1.5E+00	
2.6E-05	I	7.0E-03	P	V		Dichloroethane, 1,2-	107-06-2	9.4E-02	7.3E+00
		2.0E-01	I	V		Dichloroethylene, 1,1-	75-35-4		2.1E+02
				V		Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0		
				V		Dichloroethylene, 1,2-cis-	156-59-2		
		6.0E-02	P	V		Dichloroethylene, 1,2-trans-	156-60-5		6.3E+01

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Dichlorophenol, 2,4-	120-83-2		
						Dichlorophenoxy Acetic Acid, 2,4-	94-75-7		
						Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6		
1.0E-05	C	4.0E-03	I	V		Dichloropropane, 1,2-	78-87-5	2.4E-01	4.2E+00
				V		Dichloropropane, 1,3-	142-28-9		
						Dichloropropanol, 2,3-	616-23-9		
4.0E-06	I	2.0E-02	I	V		Dichloropropene, 1,3-	542-75-6	6.1E-01	2.1E+01
8.3E-05	C	5.0E-04	I			Dichlorvos	62-73-7	2.9E-02	5.2E-01
		7.0E-03	P	V		Dicyclopentadiene	77-73-6		7.3E+00
4.6E-03	I					Dieldrin	60-57-1	5.3E-04	
3.0E-04	C	5.0E-03	I			Diesel Engine Exhaust	NA	8.1E-03	5.2E+00
		2.0E-04	P			Diethanolamine	111-42-2		2.1E-01
						Diethyl Phthalate	84-66-2		
		1.0E-04	P			Diethylene Glycol Monobutyl Ether	112-34-5		1.0E-01
		3.0E-04	P			Diethylene Glycol Monoethyl Ether	111-90-0		3.1E-01
						Diethylformamide	617-84-5		
1.0E-01	C					Diethylstilbestrol	56-53-1	2.4E-05	
						Difenzoquat	43222-48-6		
						Diflubenzuron	35367-38-5		
		4.0E+01	I	V		Difluoroethane, 1,1-	75-37-6		4.2E+04
1.3E-05	C			V		Dihydrosafrole	94-58-6	1.9E-01	
		7.0E-01	P	V		Diisopropyl Ether	108-20-3		7.3E+02
				V		Diisopropyl Methylphosphonate	1445-75-6		
						Dimethipin	55290-64-7		
						Dimethoate	60-51-5		
						Dimethoxybenzidine, 3,3'-	119-90-4		
						Dimethyl methylphosphonate	756-79-6		
1.3E-03	C					Dimethylamino azobenzene [p-]	60-11-7	1.9E-03	
						Dimethylaniline HCl, 2,4-	21436-96-4		
						Dimethylaniline, 2,4-	95-68-1		
				V		Dimethylaniline, N,N-	121-69-7		
						Dimethylbenzidine, 3,3'-	119-93-7		
		3.0E-02	I			Dimethylformamide	68-12-2		3.1E+01
		2.0E-06	X			Dimethylhydrazine, 1,1-	57-14-7		2.1E-03
1.6E-01	C					Dimethylhydrazine, 1,2-	540-73-8	1.5E-05	
						Dimethylphenol, 2,4-	105-67-9		
						Dimethylphenol, 2,6-	576-26-1		
						Dimethylphenol, 3,4-	95-65-8		
				V		Dimethylterephthalate	120-61-6		
1.3E-05	C			V		Dimethylvinylchloride	513-37-1	1.9E-01	
						Dinitro-o-cresol, 4,6-	534-52-1		
						Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5		
						Dinitrobenzene, 1,2-	528-29-0		
						Dinitrobenzene, 1,3-	99-65-0		
						Dinitrobenzene, 1,4-	100-25-4		
						Dinitrophenol, 2,4-	51-28-5		
						Dinitrotoluene Mixture, 2,4/2,6-	NA		
8.9E-05	C					Dinitrotoluene, 2,4-	121-14-2	2.7E-02	
						Dinitrotoluene, 2,6-	606-20-2		
						Dinitrotoluene, 2-Amino-4,6-	35572-78-2		
						Dinitrotoluene, 4-Amino-2,6-	19406-51-0		
						Dinitrotoluene, Technical grade	25321-14-6		
						Dinoseb	88-85-7		
7.7E-06	C	1.1E-01	A			Dioxane, 1,4-	123-91-1	3.2E-01	1.1E+02
						Dioxins			
1.3E+00	I					~Hexachlorodibenzo-p-dioxin, Mixture	NA	1.9E-06	
3.8E+01	C	4.0E-08	C			~TCDD, 2,3,7,8-	1746-01-6	6.4E-08	4.2E-05
						Diphenamid	957-51-7		
						Diphenyl Sulfone	127-63-9		
						Diphenylamine	122-39-4		
2.2E-04	I					Diphenylhydrazine, 1,2-	122-66-7	1.1E-02	
						Diquat	85-00-7		
2.1E-03	C					Direct Black 38	1937-37-7	1.2E-03	
2.1E-03	C					Direct Blue 6	2602-46-2	1.2E-03	
1.9E-03	C					Direct Brown 95	16071-86-6	1.3E-03	
						Disulfoton	298-04-4		
				V		Dithiane, 1,4-	505-29-3		
						Diuron	330-54-1		
						Dodine	2439-10-3		
				V		EPTC	759-94-4		
						Endosulfan	115-29-7		
						Endothall	145-73-3		
						Endrin	72-20-8		
1.2E-06	I	1.0E-03	I	V		Epichlorohydrin	106-89-8	2.0E+00	1.0E+00
		2.0E-02	I	V		Epoxybutane, 1,2-	106-88-7		2.1E+01

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						Ethephon	16672-87-0		
						Ethion	563-12-2		
		6.0E-02	P			Ethoxyethanol Acetate, 2-	111-15-9		6.3E+01
		2.0E-01	I			Ethoxyethanol, 2-	110-80-5		2.1E+02
				V		Ethyl Acetate	141-78-6		
				V		Ethyl Acrylate	140-88-5		
		1.0E+01	I	V		Ethyl Chloride	75-00-3		1.0E+04
				V		Ethyl Ether	60-29-7		
		3.0E-01	P	V		Ethyl Methacrylate	97-63-2		3.1E+02
						Ethyl-p-nitrophenyl Phosphonate	2104-64-5		
2.5E-06	C	1.0E+00	I	V		Ethylbenzene	100-41-4	9.7E-01	1.0E+03
						Ethylene Cyanohydrin	109-78-4		
						Ethylene Diamine	107-15-3		
		4.0E-01	C			Ethylene Glycol	107-21-1		4.2E+02
		1.6E+00	I			Ethylene Glycol Monobutyl Ether	111-76-2		1.7E+03
8.8E-05	C	3.0E-02	C	V		Ethylene Oxide	75-21-8	2.8E-02	3.1E+01
1.3E-05	C					Ethylene Thiourea	96-45-7	1.9E-01	
1.9E-02	C			V		Ethyleneimine	151-56-4	1.3E-04	
						Ethylphthalyl Ethyl Glycolate	84-72-0		
						Express	101200-48-0		
						Fenamiphos	22224-92-6		
						Fenpropathrin	39515-41-8		
						Fluometuron	2164-17-2		
		1.3E-02	C			Fluoride	16984-48-8		1.4E+01
		1.3E-02	C			Fluorine (Soluble Fluoride)	7782-41-4		1.4E+01
						Fluridone	59756-60-4		
						Flurprimidol	56425-91-3		
						Flutolanil	66332-96-5		
						Fluvalinate	69409-94-5		
						Folpet	133-07-3		
						Fomesafen	72178-02-0		
						Fonofos	944-22-9		
1.3E-05	I	9.8E-03	A			Formaldehyde	50-00-0	1.9E-01	1.0E+01
		3.0E-04	X			Formic Acid	64-18-6		3.1E-01
						Fosetyl-AL	39148-24-8		
						Furans			
				V		~Dibenzofuran	132-64-9		
				V		~Furan	110-00-9		
		2.0E+00	I	V		~Tetrahydrofuran	109-99-9		2.1E+03
						Furazolidone	67-45-8		
		5.0E-02	H			Furfural	98-01-1		5.2E+01
4.3E-04	C					Furium	531-82-8	5.7E-03	
8.6E-06	C					Furmecyclox	60568-05-0	2.8E-01	
						Glufosinate, Ammonium	77182-82-2		
		8.0E-05	C			Glutaraldehyde	111-30-8		8.3E-02
		1.0E-03	H			Glycidyl	765-34-4		1.0E+00
						Glyphosate	1071-83-6		
						Goal	42874-03-3		
		1.0E-02	A			Guthion	86-50-0		1.0E+01
						Haloxyfop, Methyl	69806-40-2		
						Harmony	79277-27-3		
1.3E-03	I					Heptachlor	76-44-8	1.9E-03	
2.6E-03	I					Heptachlor Epoxide	1024-57-3	9.4E-04	
						Hexabromobenzene	87-82-1		
						Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2		
4.6E-04	I					Hexachlorobenzene	118-74-1	5.3E-03	
2.2E-05	I					Hexachlorobutadiene	87-68-3	1.1E-01	
1.8E-03	I					Hexachlorocyclohexane, Alpha-	319-84-6	1.4E-03	
5.3E-04	I					Hexachlorocyclohexane, Beta-	319-85-7	4.6E-03	
3.1E-04	C					Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	7.8E-03	
5.1E-04	I					Hexachlorocyclohexane, Technical	608-73-1	4.8E-03	
		2.0E-04	I			Hexachlorocyclopentadiene	77-47-4		2.1E-01
1.1E-05	C	3.0E-02	I			Hexachloroethane	67-72-1	2.2E-01	3.1E+01
						Hexachlorophene	70-30-4		
						Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4		
		1.0E-05	I	V		Hexamethylene Diisocyanate, 1,6-	822-06-0		1.0E-02
						Hexamethylphosphoramide	680-31-9		
		7.0E-01	I	V		Hexane, N-	110-54-3		7.3E+02
						Hexanedioic Acid	124-04-9		
		3.0E-02	I	V		Hexanone, 2-	591-78-6		3.1E+01
						Hexazinone	51235-04-2		
4.9E-03	I	3.0E-05	P			Hydrazine	302-01-2	5.0E-04	3.1E-02
4.9E-03	I					Hydrazine Sulfate	10034-93-2	5.0E-04	
		2.0E-02	I			Hydrogen Chloride	7647-01-0		2.1E+01
		1.4E-02	C			Hydrogen Fluoride	7664-39-3		1.5E+01

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
		2.0E-03	I			Hydrogen Sulfide	7783-06-4		2.1E+00
						Hydroquinone	123-31-9		
						Imazalil	35554-44-0		
						Imazaquin	81335-37-7		
						Iodine	7553-56-2		
						Iprodione	36734-19-7		
						Iron	7439-89-6		
						Isobutyl Alcohol	78-83-1		
		2.0E+00	C			Isophorone	78-59-1		2.1E+03
						Isopropalin	33820-53-0		
		7.0E+00	C			Isopropanol	67-63-0		7.3E+03
						Isopropyl Methyl Phosphonic Acid	1832-54-8		
						Isoxaben	82558-50-7		
		3.0E-01	A	V		JP-7	NA		3.1E+02
						Kerb	23950-58-5		
						Lactofen	77501-63-4		
						Lead Compounds			
8.0E-05	C					~Lead acetate	301-04-2	3.0E-02	
						~Lead and Compounds	7439-92-1		1.5E-01
1.1E-05	C					~Lead subacetate	1335-32-6	2.2E-01	
						~Tetraethyl Lead	78-00-2		
						Linuron	330-55-2		
						Lithium	7439-93-2		
						Londax	83055-99-6		
						MCPA	94-74-6		
						MCPB	94-81-5		
						MCPP	93-65-2		
						Malathion	121-75-5		
		7.0E-04	C			Maleic Anhydride	108-31-6		7.3E-01
						Maleic Hydrazide	123-33-1		
						Malononitrile	109-77-3		
						Mancozeb	8018-01-7		
						Maneb	12427-38-2		
		5.0E-05	I			Manganese (Diet)	7439-96-5		
		5.0E-05	I			Manganese (Non-diet)	7439-96-5		5.2E-02
						Mephosfolan	950-10-7		
						Mepiquat Chloride	24307-26-4		
						Mercury Compounds			
		3.0E-04	S			~Mercuric Chloride (and other Mercury salts)	7487-94-7		3.1E-01
		3.0E-04	I	V		~Mercury (elemental)	7439-97-6		3.1E-01
						~Methyl Mercury	22967-92-6		
						~Phenylmercuric Acetate	62-38-4		
						Merphos	150-50-5		
						Merphos Oxide	78-48-8		
						Metalaxyl	57837-19-1		
		3.0E-02	P	V		Methacrylonitrile	126-98-7		3.1E+01
						Methamidophos	10265-92-6		
		4.0E+00	C			Methanol	67-56-1		4.2E+03
						Methidathion	950-37-8		
						Methomyl	16752-77-5		
1.4E-05	C					Methoxy-5-nitroaniline, 2-	99-59-2	1.7E-01	
						Methoxychlor	72-43-5		
		1.0E-03	P			Methoxyethanol Acetate, 2-	110-49-6		1.0E+00
		2.0E-02	I			Methoxyethanol, 2-	109-86-4		2.1E+01
				V		Methyl Acetate	79-20-9		
		2.0E-02	P	V		Methyl Acrylate	96-33-3		2.1E+01
		5.0E+00	I	V		Methyl Ethyl Ketone (2-Butanone)	78-93-3		5.2E+03
1.0E-03	X	2.0E-05	X			Methyl Hydrazine	60-34-4	2.4E-03	2.1E-02
		3.0E+00	I	V		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1		3.1E+03
		1.0E-03	C	V		Methyl Isocyanate	624-83-9		1.0E+00
		7.0E-01	I	V		Methyl Methacrylate	80-62-6		7.3E+02
						Methyl Parathion	298-00-0		
						Methyl Phosphonic Acid	993-13-5		
		4.0E-02	H	V		Methyl Styrene (Mixed Isomers)	25013-15-4		4.2E+01
2.8E-05	C					Methyl methanesulfonate	66-27-3	8.7E-02	
2.6E-07	C	3.0E+00	I	V		Methyl tert-Butyl Ether (MTBE)	1634-04-4	9.4E+00	3.1E+03
						Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2		
						Methyl-5-Nitroaniline, 2-	99-55-8		
2.4E-03	C					Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	1.0E-03	
3.7E-05	C					Methylaniline Hydrochloride, 2-	636-21-5	6.6E-02	
						Methylarsonic acid	124-58-3		
						Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7		
						Methylbenzene-1,4-diamine sulfate, 2-	615-50-9		
6.3E-03	C				M	Methylcholanthrene, 3-	56-49-5	1.5E-04	
1.0E-08	I	6.0E-01	I	V	M	Methylene Chloride	75-09-2	9.6E+01	6.3E+02

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
4.3E-04	C				M	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.2E-03	
1.3E-05	C					Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.9E-01	
4.6E-04	C	2.0E-02	C			Methylenebisbenzenamine, 4,4'-	101-77-9	5.3E-03	2.1E+01
		6.0E-04	I			Methylenediphenyl Diisocyanate	101-68-8		6.3E-01
				V		Methylstyrene, Alpha-	98-83-9		
						Metolachlor	51218-45-2		
						Metribuzin	21087-64-9		
				V		Mineral oils	8012-95-1		
5.1E-03	C					Mirex	2385-85-5	4.8E-04	
						Molinate	2212-67-1		
						Molybdenum	7439-98-7		
						Monochloramine	10599-90-3		
						Monomethylaniline	100-61-8		
						N,N'-Diphenyl-1,4-benzenediamine	74-31-7		
						Naled	300-76-5		
		1.0E-01	P	V		Naphtha, High Flash Aromatic (HFAN)	64724-95-6		1.0E+02
0.0E+00	C					Naphthylamine, 2-	91-59-8		
						Napropamide	15299-99-7		
		1.4E-05	C			Nickel Carbonyl	13463-39-3		1.5E-02
		2.0E-05	C			Nickel Oxide	1313-99-1		2.1E-02
2.4E-04	I	1.4E-05	C			Nickel Refinery Dust	NA	1.0E-02	1.5E-02
2.6E-04	C	9.0E-05	A			Nickel Soluble Salts	7440-02-0	9.4E-03	9.4E-02
4.8E-04	I	1.4E-05	C			Nickel Subsulfide	12035-72-2	5.1E-03	1.5E-02
						Nitrate	14797-55-8		
						Nitrate + Nitrite (as N)	NA		
						Nitrite	14797-65-0		
		5.0E-05	X			Nitroaniline, 2-	88-74-4		5.2E-02
		6.0E-03	P			Nitroaniline, 4-	100-01-6		6.3E+00
4.0E-05	I	9.0E-03	I	V		Nitrobenzene	98-95-3	6.1E-02	9.4E+00
						Nitrocellulose	9004-70-0		
						Nitrofurantoin	67-20-9		
3.7E-04	C					Nitrofurazone	59-87-0	6.6E-03	
						Nitroglycerin	55-63-0		
						Nitroguanidine	556-88-7		
9.0E-06	P	2.0E-02	P	V		Nitromethane	75-52-5	2.7E-01	2.1E+01
2.7E-03	H	2.0E-02	I	V		Nitropropane, 2-	79-46-9	9.0E-04	2.1E+01
7.7E-03	C				M	Nitroso-N-ethylurea, N-	759-73-9	1.2E-04	
3.4E-02	C				M	Nitroso-N-methylurea, N-	684-93-5	2.8E-05	
1.6E-03	I			V		Nitroso-di-N-butylamine, N-	924-16-3	1.5E-03	
2.0E-03	C					Nitroso-di-N-propylamine, N-	621-64-7	1.2E-03	
8.0E-04	C					Nitrosodiethanolamine, N-	1116-54-7	3.0E-03	
4.3E-02	I				M	Nitrosodiethylamine, N-	55-18-5	2.2E-05	
1.4E-02	I	4.0E-05	X		M	Nitrosodimethylamine, N-	62-75-9	6.9E-05	4.2E-02
2.6E-06	C					Nitrosodiphenylamine, N-	86-30-6	9.4E-01	
6.3E-03	C					Nitrosomethylethylamine, N-	10595-95-6	3.9E-04	
1.9E-03	C					Nitrosomorpholine [N-]	59-89-2	1.3E-03	
2.7E-03	C					Nitrosopiperidine [N-]	100-75-4	9.0E-04	
6.1E-04	I					Nitrosopyrrolidine, N-	930-55-2	4.0E-03	
						Nitrotoluene, m-	99-08-1		
				V		Nitrotoluene, o-	88-72-2		
						Nitrotoluene, p-	99-99-0		
		2.0E-01	P	V		Nonane, n-	111-84-2		2.1E+02
						Norflurazon	27314-13-2		
						Nustar	85509-19-9		
						Octabromodiphenyl Ether	32536-52-0		
						Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0		
						Octamethylpyrophosphoramide	152-16-9		
						Octyl Phthalate, di-N-	117-84-0		
						Oryzalin	19044-88-3		
						Oxadiazon	19666-30-9		
						Oxamyl	23135-22-0		
						Paclobutrazol	76738-62-0		
						Paraquat Dichloride	1910-42-5		
						Parathion	56-38-2		
						Pebulate	1114-71-2		
						Pendimethalin	40487-42-1		
						Pentabromodiphenyl Ether	32534-81-9		
						Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9		
						Pentachlorobenzene	608-93-5		
						Pentachloroethane	76-01-7		
						Pentachloronitrobenzene	82-68-8		
5.1E-06	C					Pentachlorophenol	87-86-5	4.8E-01	
						Pentaerythritol tetranitrate (PETN)	78-11-5		
		1.0E+00	P	V		Pentane, n-	109-66-0		1.0E+03
						Perchlorates			

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						~Ammonium Perchlorate	7790-98-9		
						~Lithium Perchlorate	7791-03-9		
						~Perchlorate and Perchlorate Salts	14797-73-0		
						~Potassium Perchlorate	7778-74-7		
						~Sodium Perchlorate	7601-89-0		
						Permethrin	52645-53-1		
6.3E-07	C					Phenacetin	62-44-2	3.9E+00	
						Phenmedipham	13684-63-4		
		2.0E-01	C			Phenol	108-95-2		2.1E+02
						Phenothiazine	92-84-2		
						Phenylenediamine, m-	108-45-2		
						Phenylenediamine, o-	95-54-5		
						Phenylenediamine, p-	106-50-3		
						Phenylphenol, 2-	90-43-7		
						Phorate	298-02-2		
		3.0E-04	I	V		Phosgene	75-44-5		3.1E-01
						Phosmet	732-11-6		
						Phosphates, Inorganic			
						~Aluminum metaphosphate	13776-88-0		
						~Ammonium polyphosphate	68333-79-9		
						~Calcium pyrophosphate	7790-76-3		
						~Diammonium phosphate	7783-28-0		
						~Dicalcium phosphate	7757-93-9		
						~Dimagnesium phosphate	7782-75-4		
						~Dipotassium phosphate	7758-11-4		
						~Disodium phosphate	7558-79-4		
						~Monoaluminum phosphate	13530-50-2		
						~Monoammonium phosphate	7722-76-1		
						~Monocalcium phosphate	7758-23-8		
						~Monomagnesium phosphate	7757-86-0		
						~Monopotassium phosphate	7778-77-0		
						~Monosodium phosphate	7558-80-7		
						~Polyphosphoric acid	8017-16-1		
						~Potassium tripolyphosphate	13845-36-8		
						~Sodium acid pyrophosphate	7758-16-9		
						~Sodium aluminum phosphate (acidic)	7785-88-8		
						~Sodium aluminum phosphate (anhydrous)	10279-59-1		
						~Sodium aluminum phosphate (tetrahydrate)	10305-76-7		
						~Sodium hexametaphosphate	10124-56-8		
						~Sodium polyphosphate	68915-31-1		
						~Sodium trimetaphosphate	7785-84-4		
						~Sodium tripolyphosphate	7758-29-4		
						~Tetrapotassium phosphate	7320-34-5		
						~Tetrasodium pyrophosphate	7722-88-5		
						~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5		
						~Tricalcium phosphate	7758-87-4		
						~Trimagnesium phosphate	7757-87-1		
						~Tripotassium phosphate	7778-53-2		
						~Trisodium phosphate	7601-54-9		
		3.0E-04	I			Phosphine	7803-51-2		3.1E-01
		1.0E-02	I			Phosphoric Acid	7664-38-2		1.0E+01
						Phosphorus, White	7723-14-0		
						Phthalic Acid, P-	100-21-0		
		2.0E-02	C			Phthalic Anhydride	85-44-9		2.1E+01
						Picloram	1918-02-1		
						Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3		
						Pirimiphos, Methyl	29232-93-7		
8.6E-03	C					Polybrominated Biphenyls	59536-65-1	2.8E-04	
						Polychlorinated Biphenyls (PCBs)			
2.0E-05	S					~Aroclor 1016	12674-11-2	1.2E-01	
5.7E-04	S			V		~Aroclor 1221	11104-28-2	4.3E-03	
5.7E-04	S			V		~Aroclor 1232	11141-16-5	4.3E-03	
5.7E-04	S					~Aroclor 1242	53469-21-9	4.3E-03	
5.7E-04	S					~Aroclor 1248	12672-29-6	4.3E-03	
5.7E-04	S					~Aroclor 1254	11097-69-1	4.3E-03	
5.7E-04	S					~Aroclor 1260	11096-82-5	4.3E-03	
1.1E-03	E	1.3E-03	E			~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	2.1E-03	1.4E+00
1.1E+00	E	1.3E-06	E			~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	2.1E-06	1.4E-03
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	2.1E-03	1.4E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	2.1E-03	1.4E+00

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
3.8E+00	E	4.0E-07	E			~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	6.4E-07	4.2E-04
5.7E-04	I					~Polychlorinated Biphenyls (high risk)	1336-36-3	4.3E-03	
1.0E-04	I					~Polychlorinated Biphenyls (low risk)	1336-36-3	2.4E-02	
2.0E-05	I					~Polychlorinated Biphenyls (lowest risk)	1336-36-3	1.2E-01	
3.8E-03	E	4.0E-04	E			~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	6.4E-04	4.2E-01
1.1E-02	E	1.3E-04	E			~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	2.1E-04	1.4E-01
		6.0E-04	I			Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9		6.3E-01
						Polynuclear Aromatic Hydrocarbons (PAHs)			
				V		~Acenaphthene	83-32-9		
				V		~Anthracene	120-12-7		
1.1E-04	C				M	~Benz[a]anthracene	56-55-3	8.7E-03	
1.1E-04	C					~Benzo(j)fluoranthene	205-82-3	2.2E-02	
1.1E-03	C				M	~Benzo[a]pyrene	50-32-8	8.7E-04	
1.1E-04	C				M	~Benzo[b]fluoranthene	205-99-2	8.7E-03	
1.1E-04	C				M	~Benzo[k]fluoranthene	207-08-9	8.7E-03	
1.1E-05	C				M	~Chrysene	218-01-9	8.7E-02	
1.2E-03	C				M	~Dibenz[a,h]anthracene	53-70-3	8.0E-04	
1.1E-03	C					~Dibenzo(a,e)pyrene	192-65-4	2.2E-03	
7.1E-02	C				M	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	1.4E-05	
						~Fluoranthene	206-44-0		
				V		~Fluorene	86-73-7		
1.1E-04	C				M	~Indeno[1,2,3-cd]pyrene	193-39-5	8.7E-03	
				V		~Methylnaphthalene, 1-	90-12-0		
				V		~Methylnaphthalene, 2-	91-57-6		
3.4E-05	C	3.0E-03	I	V		~Naphthalene	91-20-3	7.2E-02	3.1E+00
1.1E-04	C					~Nitropyrene, 4-	57835-92-4	2.2E-02	
				V		~Pyrene	129-00-0		
						Prochloraz	67747-09-5		
						Profluralin	26399-36-0		
						Prometon	1610-18-0		
						Prometryn	7287-19-6		
						Propachlor	1918-16-7		
						Propanil	709-98-8		
						Propargite	2312-35-8		
						Propargyl Alcohol	107-19-7		
						Propazine	139-40-2		
						Propham	122-42-9		
						Propiconazole	60207-90-1		
		8.0E-03	I	V		Propionaldehyde	123-38-6		8.3E+00
		1.0E+00	X	V		Propyl benzene	103-65-1		1.0E+03
		3.0E+00	C	V		Propylene	115-07-1		3.1E+03
						Propylene Glycol	57-55-6		
		2.7E-04	A			Propylene Glycol Dinitrate	6423-43-4		2.8E-01
						Propylene Glycol Monoethyl Ether	1569-02-4		
		2.0E+00	I			Propylene Glycol Monomethyl Ether	107-98-2		2.1E+03
3.7E-06	I	3.0E-02	I	V		Propylene Oxide	75-56-9	6.6E-01	3.1E+01
						Pursuit	81335-77-5		
						Pydrin	51630-58-1		
				V		Pyridine	110-86-1		
						Quinalphos	13593-03-8		
						Quinoline	91-22-5		
		3.0E-02	A			Refractory Ceramic Fibers	NA		3.1E+01
						Resmethrin	10453-86-8		
						Ronnel	299-84-3		
						Rotenone	83-79-4		
6.3E-05	C				M	Safrole	94-59-7	1.5E-02	
						Savey	78587-05-0		
						Selenious Acid	7783-00-8		
		2.0E-02	C			Selenium	7782-49-2		2.1E+01
		2.0E-02	C			Selenium Sulfide	7446-34-6		2.1E+01
						Sethoxydim	74051-80-2		
		3.0E-03	C			Silica (crystalline, respirable)	7631-86-9		3.1E+00
						Silver	7440-22-4		
						Simazine	122-34-9		
						Sodium Acifluorfen	62476-59-9		
						Sodium Azide	26628-22-8		
						Sodium Diethyldithiocarbamate	148-18-5		
		1.3E-02	C			Sodium Fluoride	7681-49-4		1.4E+01
						Sodium Fluoroacetate	62-74-8		
						Sodium Metavanadate	13718-26-8		
						Stirofos (Tetrachlorovinphos)	961-11-5		
						Strontium, Stable	7440-24-6		
						Strychnine	57-24-9		
		1.0E+00	I	V		Styrene	100-42-5		1.0E+03
		2.0E-03	P			Sulfolane	126-33-0		2.1E+00

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
		1.0E-03	C			Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9		
						Sulfuric Acid	7664-93-9		1.0E+00
						Systhane	88671-89-0		
						TCMTB	21564-17-0		
						Tebuthiuron	34014-18-1		
						Temephos	3383-96-8		
						Terbacil	5902-51-2		
						Terbufos	13071-79-9		
						Terbutryn	886-50-0		
						Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1		
						Tetrachlorobenzene, 1,2,4,5-	95-94-3		
7.4E-06	I			V		Tetrachloroethane, 1,1,1,2-	630-20-6	3.3E-01	
5.8E-05	C			V		Tetrachloroethane, 1,1,2,2-	79-34-5	4.2E-02	
2.6E-07	I	4.0E-02	I	V		Tetrachloroethylene	127-18-4	9.4E+00	4.2E+01
						Tetrachlorophenol, 2,3,4,6-	58-90-2		
						Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1		
						Tetraethyl Dithiopyrophosphate	3689-24-5		
		8.0E+01	I	V		Tetrafluoroethane, 1,1,1,2-	811-97-2		8.3E+04
						Tetryl (Trinitrophenylmethylnitramine)	479-45-8		
						Thallium (I) Nitrate	10102-45-1		
						Thallium (Soluble Salts)	7440-28-0		
						Thallium Acetate	563-68-8		
						Thallium Carbonate	6533-73-9		
						Thallium Chloride	7791-12-0		
						Thallium Sulfate	7446-18-6		
						Thiobencarb	28249-77-6		
						Thiodiglycol	111-48-8		
						Thiofanox	39196-18-4		
						Thiophanate, Methyl	23564-05-8		
						Thiram	137-26-8		
						Tin	7440-31-5		
		1.0E-04	A			Titanium Tetrachloride	7550-45-0		1.0E-01
		5.0E+00	I	V		Toluene	108-88-3		5.2E+03
						Toluene-2,5-diamine	95-70-5		
						Toluidine, p-	106-49-0		
3.2E-04	I					Toxaphene	8001-35-2	7.6E-03	
						Tralomethrin	66841-25-6		
						Tri-n-butyltin	688-73-3		
						Triacetin	102-76-1		
						Triallate	2303-17-5		
						Triasulfuron	82097-50-5		
						Tribromobenzene, 1,2,4-	615-54-3		
						Tributyl Phosphate	126-73-8		
						Tributyltin Compounds	NA		
						Tributyltin Oxide	56-35-9		
		3.0E+01	H	V		Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1		3.1E+04
						Trichloroacetic Acid	76-03-9		
						Trichloroaniline HCl, 2,4,6-	33663-50-2		
						Trichloroaniline, 2,4,6-	634-93-5		
				V		Trichlorobenzene, 1,2,3-	87-61-6		
		2.0E-03	P	V		Trichlorobenzene, 1,2,4-	120-82-1		2.1E+00
		5.0E+00	I	V		Trichloroethane, 1,1,1-	71-55-6		5.2E+03
1.6E-05	I	2.0E-04	X	V		Trichloroethane, 1,1,2-	79-00-5	1.5E-01	2.1E-01
4.1E-06	I	2.0E-03	I	V	M	Trichloroethylene	79-01-6	4.3E-01	2.1E+00
		7.0E-01	H	V		Trichlorofluoromethane	75-69-4		7.3E+02
						Trichlorophenol, 2,4,5-	95-95-4		
3.1E-06	I					Trichlorophenol, 2,4,6-	88-06-2	7.8E-01	
						Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5		
						Trichlorophenoxypropionic acid, -2,4,5	93-72-1		
				V		Trichloropropane, 1,1,2-	598-77-6		
		3.0E-04	I	V	M	Trichloropropane, 1,2,3-	96-18-4		3.1E-01
		3.0E-04	P	V		Trichloropropene, 1,2,3-	96-19-5		3.1E-01
						Tricresyl Phosphate (TCP)	1330-78-5		
						Tridiphane	58138-08-2		
		7.0E-03	I	V		Triethylamine	121-44-8		7.3E+00
						Trifluralin	1582-09-8		
						Trimethyl Phosphate	512-56-1		
		5.0E-03	P	V		Trimethylbenzene, 1,2,3-	526-73-8		5.2E+00
		7.0E-03	P	V		Trimethylbenzene, 1,2,4-	95-63-6		7.3E+00
				V		Trimethylbenzene, 1,3,5-	108-67-8		
						Trinitrobenzene, 1,3,5-	99-35-4		
						Trinitrotoluene, 2,4,6-	118-96-7		
						Triphenylphosphine Oxide	791-28-6		
						Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8		
						Tris(1-chloro-2-propyl)phosphate	13674-84-5		

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Tris(2-chloroethyl)phosphate	115-96-8		
						Tris(2-ethylhexyl)phosphate	78-42-2		
		4.0E-05	A			Uranium (Soluble Salts)	NA		4.2E-02
2.9E-04	C				M	Urethane	51-79-6	3.3E-03	
8.3E-03	P	7.0E-06	P			Vanadium Pentoxide	1314-62-1	2.9E-04	7.3E-03
		1.0E-04	A			Vanadium and Compounds	7440-62-2		1.0E-01
						Vernolate	1929-77-7		
						Vinclozolin	50471-44-8		
		2.0E-01	I	V		Vinyl Acetate	108-05-4		2.1E+02
3.2E-05	H	3.0E-03	I	V		Vinyl Bromide	593-60-2	7.6E-02	3.1E+00
4.4E-06	I	1.0E-01	I	V	M	Vinyl Chloride	75-01-4	1.6E-01	1.0E+02
						Warfarin	81-81-2		
		1.0E-01	S	V		Xylene, P-	106-42-3		1.0E+02
		1.0E-01	S	V		Xylene, m-	108-38-3		1.0E+02
		1.0E-01	S	V		Xylene, o-	95-47-6		1.0E+02
		1.0E-01	I	V		Xylenes	1330-20-7		1.0E+02
						Zinc Phosphide	1314-84-7		
						Zinc and Compounds	7440-66-6		
						Zineb	12122-67-7		
						Zirconium	7440-67-7		

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
5.1E-06	C					ALAR	1596-84-5	2.4E+00	
						Acephate	30560-19-1		
2.2E-06	I	9.0E-03	I	V		Acetaldehyde	75-07-0	5.6E+00	3.9E+01
						Acetochlor	34256-82-1		
		3.1E+01	A	V		Acetone	67-64-1		1.4E+05
		2.0E-03	X	V		Acetone Cyanohydrin	75-86-5		8.8E+00
		6.0E-02	I	V		Acetonitrile	75-05-8		2.6E+02
				V		Acetophenone	98-86-2		
1.3E-03	C					Acetylaminofluorene, 2-	53-96-3	9.4E-03	
		2.0E-05	I	V		Acrolein	107-02-8		8.8E-02
1.0E-04	I	6.0E-03	I		M	Acrylamide	79-06-1	1.2E-01	2.6E+01
		1.0E-03	I			Acrylic Acid	79-10-7		4.4E+00
6.8E-05	I	2.0E-03	I	V		Acrylonitrile	107-13-1	1.8E-01	8.8E+00
		6.0E-03	P			Adiponitrile	111-69-3		2.6E+01
						Alachlor	15972-60-8		
						Aldicarb	116-06-3		
						Aldicarb Sulfone	1646-88-4		
						Aldicarb sulfoxide	1646-87-3		
4.9E-03	I					Aldrin	309-00-2	2.5E-03	
						Ally	74223-64-6		
		1.0E-04	X			Allyl Alcohol	107-18-6		4.4E-01
6.0E-06	C	1.0E-03	I	V		Allyl Chloride	107-05-1	2.0E+00	4.4E+00
		5.0E-03	P			Aluminum	7429-90-5		2.2E+01
						Aluminum Phosphide	20859-73-8		
						Amdro	67485-29-4		
						Ametryn	834-12-8		
6.0E-03	C					Aminobiphenyl, 4-	92-67-1	2.0E-03	
						Aminophenol, m-	591-27-5		
						Aminophenol, p-	123-30-8		
						Amitraz	33089-61-1		
		1.0E-01	I			Ammonia	7664-41-7		4.4E+02
						Ammonium Sulfamate	7773-06-0		
1.6E-06	C	1.0E-03	I			Aniline	62-53-3	7.7E+00	4.4E+00
						Anthraquinone, 9,10-	84-65-1		
						Antimony (metallic)	7440-36-0		
						Antimony Pentoxide	1314-60-9		
						Antimony Potassium Tartrate	11071-15-1		
						Antimony Tetroxide	1332-81-6		
		2.0E-04	I			Antimony Trioxide	1309-64-4		8.8E-01
						Apollo	74115-24-5		
7.1E-06	I					Aramite	140-57-8	1.7E+00	
4.3E-03	I	1.5E-05	C			Arsenic, Inorganic	7440-38-2	2.9E-03	6.6E-02
		5.0E-05	I			Arsine	7784-42-1		2.2E-01
						Assure	76578-14-8		
						Asulam	3337-71-1		
						Atrazine	1912-24-9		
2.5E-04	C					Auramine	492-80-8	4.9E-02	
						Avermectin B1	65195-55-3		
3.1E-05	I			V		Azobenzene	103-33-3	4.0E-01	
		5.0E-04	H			Barium	7440-39-3		2.2E+00
						Baygon	114-26-1		
						Bayleton	43121-43-3		
						Baythroid	68359-37-5		
						Benefin	1861-40-1		
						Benomyl	17804-35-2		
						Bentazon	25057-89-0		
				V		Benzaldehyde	100-52-7		
7.8E-06	I	3.0E-02	I	V		Benzene	71-43-2	1.6E+00	1.3E+02
						Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1		
				V		Benzenethiol	108-98-5		
6.7E-02	I				M	Benzidine	92-87-5	1.8E-04	
						Benzoic Acid	65-85-0		
				V		Benzotrichloride	98-07-7		
						Benzyl Alcohol	100-51-6		
4.9E-05	C	1.0E-03	P	V		Benzyl Chloride	100-44-7	2.5E-01	4.4E+00
2.4E-03	I	2.0E-05	I			Beryllium and compounds	7440-41-7	5.1E-03	8.8E-02
						Bidrin	141-66-2		
						Bifenox	42576-02-3		
						Biphenthrin	82657-04-3		
		4.0E-04	X	V		Biphenyl, 1,1'-	92-52-4		1.8E+00
1.0E-05	H			V		Bis(2-chloro-1-methylethyl) ether	108-60-1	1.2E+00	
						Bis(2-chloroethoxy)methane	111-91-1		
3.3E-04	I			V		Bis(2-chloroethyl)ether	111-44-4	3.7E-02	
2.4E-06	C					Bis(2-ethylhexyl)phthalate	117-81-7	5.1E+00	
6.2E-02	I			V		Bis(chloromethyl)ether	542-88-1	2.0E-04	

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Toxicity and Chemical-specific Information							Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen		Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
							Bisphenol A	80-05-7		
		2.0E-02	H				Boron And Borates Only	7440-42-8		8.8E+01
		2.0E-02	P				Boron Trichloride	10294-34-5		8.8E+01
		1.3E-02	C				Boron Trifluoride	7637-07-2		5.7E+01
							Bromate	15541-45-4		
6.0E-04	X			V			Bromo-2-chloroethane, 1-	107-04-0	2.0E-02	
		6.0E-02	I	V			Bromobenzene	108-86-1		2.6E+02
		4.0E-02	X	V			Bromochloromethane	74-97-5		1.8E+02
3.7E-05	C			V			Bromodichloromethane	75-27-4	3.3E-01	
1.1E-06	I						Bromoform	75-25-2	1.1E+01	
		5.0E-03	I	V			Bromomethane	74-83-9		2.2E+01
							Bromophos	2104-96-3		
							Bromoxynil	1689-84-5		
							Bromoxynil Octanoate	1689-99-2		
3.0E-05	I	2.0E-03	I	V			Butadiene, 1,3-	106-99-0	4.1E-01	8.8E+00
							Butanol, N-	71-36-3		
							Butyl Benzyl Phthlate	85-68-7		
		3.0E+01	P				Butyl alcohol, sec-	78-92-2		1.3E+05
							Butylate	2008-41-5		
5.7E-08	C						Butylated hydroxyanisole	25013-16-5	2.2E+02	
				V			Butylbenzene, n-	104-51-8		
				V			Butylbenzene, sec-	135-98-8		
				V			Butylbenzene, tert-	98-06-6		
							Butylphthalyl Butylglycolate	85-70-1		
							Cacodylic Acid	75-60-5		
1.8E-03	I	1.0E-05	A				Cadmium (Diet)	7440-43-9		
1.8E-03	I	1.0E-05	A				Cadmium (Water)	7440-43-9	6.8E-03	4.4E-02
							Caprolactam	105-60-2		
4.3E-05	C						Captafol	2425-06-1	2.9E-01	
6.6E-07	C						Captan	133-06-2	1.9E+01	
							Carbaryl	63-25-2		
							Carbofuran	1563-66-2		
		7.0E-01	I	V			Carbon Disulfide	75-15-0		3.1E+03
6.0E-06	I	1.0E-01	I	V			Carbon Tetrachloride	56-23-5	2.0E+00	4.4E+02
							Carbosulfan	55285-14-8		
							Carboxin	5234-68-4		
		9.0E-04	I				Ceric oxide	1306-38-3		3.9E+00
							Chloral Hydrate	302-17-0		
							Chloramben	133-90-4		
							Chloranil	118-75-2		
1.0E-04	I	7.0E-04	I				Chlordane	12789-03-6	1.2E-01	3.1E+00
4.6E-03	C						Chlordecone (Kepone)	143-50-0	2.7E-03	
							Chlorfenvinphos	470-90-6		
							Chlorimuron, Ethyl-	90982-32-4		
		1.5E-04	A				Chlorine	7782-50-5		6.4E-01
		2.0E-04	I				Chlorine Dioxide	10049-04-4		8.8E-01
							Chlorite (Sodium Salt)	7758-19-2		
		5.0E+01	I	V			Chloro-1,1-difluoroethane, 1-	75-68-3		2.2E+05
3.0E-04	I	2.0E-02	I	V			Chloro-1,3-butadiene, 2-	126-99-8	4.1E-02	8.8E+01
							Chloro-2-methylaniline HCl, 4-	3165-93-3		
7.7E-05	C						Chloro-2-methylaniline, 4-	95-69-2	1.6E-01	
				V			Chloroacetaldehyde, 2-	107-20-0		
							Chloroacetic Acid	79-11-8		
		3.0E-05	I				Chloroacetophenone, 2-	532-27-4		1.3E-01
							Chloroaniline, p-	106-47-8		
		5.0E-02	P	V			Chlorobenzene	108-90-7		2.2E+02
3.1E-05	C						Chlorobenzilate	510-15-6	4.0E-01	
							Chlorobenzoic Acid, p-	74-11-3		
		3.0E-01	P	V			Chlorobenzotrifluoride, 4-	98-56-6		1.3E+03
				V			Chlorobutane, 1-	109-69-3		
		5.0E+01	I	V			Chlorodifluoromethane	75-45-6		2.2E+05
							Chloroethanol, 2-	107-07-3		
2.3E-05	I	9.8E-02	A	V			Chloroform	67-66-3	5.3E-01	4.3E+02
		9.0E-02	I	V			Chloromethane	74-87-3		3.9E+02
6.9E-04	C			V			Chloromethyl Methyl Ether	107-30-2	1.8E-02	
				V			Chloronaphthalene, Beta-	91-58-7		
		1.0E-05	X				Chloronitrobenzene, o-	88-73-3		4.4E-02
		6.0E-04	P				Chloronitrobenzene, p-	100-00-5		2.6E+00
				V			Chlorophenol, 2-	95-57-8		
		4.0E-04	C	V			Chloropicrin	76-06-2		1.8E+00
8.9E-07	C						Chlorothalonil	1897-45-6	1.4E+01	
				V			Chlorotoluene, o-	95-49-8		
				V			Chlorotoluene, p-	106-43-4		
6.9E-02	C						Chlorozotocin	54749-90-5	1.8E-04	
							Chlorpropham	101-21-3		

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Chlorpyrifos	2921-88-2		
						Chlorpyrifos Methyl	5598-13-0		
						Chlorsulfuron	64902-72-3		
						Chlorthiophos	60238-56-4		
						Chromium(III), Insoluble Salts	16065-83-1		
8.4E-02	S	1.0E-04	I		M	Chromium(VI)	18540-29-9	1.5E-04	4.4E-01
						Chromium, Total	7440-47-3		
9.0E-03	P	6.0E-06	P			Cobalt	7440-48-4	1.4E-03	2.6E-02
6.2E-04	I				M	Coke Oven Emissions	8007-45-2	2.0E-02	
						Copper	7440-50-8		
		6.0E-01	C			Cresol, m-	108-39-4		2.6E+03
		6.0E-01	C			Cresol, o-	95-48-7		2.6E+03
		6.0E-01	C			Cresol, p-	106-44-5		2.6E+03
						Cresol, p-chloro-m-	59-50-7		
		6.0E-01	C			Cresols	1319-77-3		2.6E+03
				V		Crotonaldehyde, trans-	123-73-9		
		4.0E-01	I	V		Cumene	98-82-8		1.8E+03
6.3E-05	C					Cupferron	135-20-6	1.9E-01	
						Cyanazine	21725-46-2		
						Cyanides			
						~Calcium Cyanide	592-01-8		
						~Copper Cyanide	544-92-3		
		8.0E-04	S	V		~Cyanide (CN-)	57-12-5		3.5E+00
				V		~Cyanogen	460-19-5		
				V		~Cyanogen Bromide	506-68-3		
				V		~Cyanogen Chloride	506-77-4		
		8.0E-04	I	V		~Hydrogen Cyanide	74-90-8		3.5E+00
						~Potassium Cyanide	151-50-8		
						~Potassium Silver Cyanide	506-61-6		
						~Silver Cyanide	506-64-9		
						~Sodium Cyanide	143-33-9		
						~Thiocyanates	NA		
						~Thiocyanic Acid	463-56-9		
						~Zinc Cyanide	557-21-1		
		6.0E+00	I	V		Cyclohexane	110-82-7		2.6E+04
						Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3		
		7.0E-01	P			Cyclohexanone	108-94-1		3.1E+03
		1.0E+00	X	V		Cyclohexene	110-83-8		4.4E+03
						Cyclohexylamine	108-91-8		
						Cyhalothrin/karate	68085-85-8		
						Cypermethrin	52315-07-8		
						Cyromazine	66215-27-8		
6.9E-05	C					DDD	72-54-8	1.8E-01	
9.7E-05	C					DDE, p,p'-	72-55-9	1.3E-01	
9.7E-05	I					DDT	50-29-3	1.3E-01	
						Dacthal	1861-32-1		
						Dalapon	75-99-0		
						Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5		
						Demeton	8065-48-3		
						Di(2-ethylhexyl)adipate	103-23-1		
						Diallate	2303-16-4		
						Diazinon	333-41-5		
6.0E-03	P	2.0E-04	I	V	M	Dibromo-3-chloropropane, 1,2-	96-12-8	2.0E-03	8.8E-01
						Dibromobenzene, 1,4-	106-37-6		
2.7E-05	C			V		Dibromochloromethane	124-48-1	4.5E-01	
6.0E-04	I	9.0E-03	I	V		Dibromoethane, 1,2-	106-93-4	2.0E-02	3.9E+01
		4.0E-03	X	V		Dibromomethane (Methylene Bromide)	74-95-3		1.8E+01
						Dibutyl Phthalate	84-74-2		
						Dibutyltin Compounds	NA		
						Dicamba	1918-00-9		
4.2E-03	P			V		Dichloro-2-butene, 1,4-	764-41-0	2.9E-03	
4.2E-03	P			V		Dichloro-2-butene, cis-1,4-	1476-11-5	2.9E-03	
4.2E-03	P			V		Dichloro-2-butene, trans-1,4-	110-57-6	2.9E-03	
						Dichloroacetic Acid	79-43-6		
		2.0E-01	H	V		Dichlorobenzene, 1,2-	95-50-1		8.8E+02
1.1E-05	C	8.0E-01	I	V		Dichlorobenzene, 1,4-	106-46-7	1.1E+00	3.5E+03
3.4E-04	C					Dichlorobenzidine, 3,3'-	91-94-1	3.6E-02	
						Dichlorobenzophenone, 4,4'-	90-98-2		
		1.0E-01	X	V		Dichlorodifluoromethane	75-71-8		4.4E+02
1.6E-06	C			V		Dichloroethane, 1,1-	75-34-3	7.7E+00	
2.6E-05	I	7.0E-03	P	V		Dichloroethane, 1,2-	107-06-2	4.7E-01	3.1E+01
		2.0E-01	I	V		Dichloroethylene, 1,1-	75-35-4		8.8E+02
				V		Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0		
				V		Dichloroethylene, 1,2-cis-	156-59-2		
		6.0E-02	P	V		Dichloroethylene, 1,2-trans-	156-60-5		2.6E+02

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Dichlorophenol, 2,4-	120-83-2		
						Dichlorophenoxy Acetic Acid, 2,4-	94-75-7		
						Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6		
1.0E-05	C	4.0E-03	I	V		Dichloropropane, 1,2-	78-87-5	1.2E+00	1.8E+01
				V		Dichloropropane, 1,3-	142-28-9		
						Dichloropropanol, 2,3-	616-23-9		
4.0E-06	I	2.0E-02	I	V		Dichloropropene, 1,3-	542-75-6	3.1E+00	8.8E+01
8.3E-05	C	5.0E-04	I			Dichlorvos	62-73-7	1.5E-01	2.2E+00
		7.0E-03	P	V		Dicyclopentadiene	77-73-6		3.1E+01
4.6E-03	I					Dieldrin	60-57-1	2.7E-03	
3.0E-04	C	5.0E-03	I			Diesel Engine Exhaust	NA	4.1E-02	2.2E+01
		2.0E-04	P			Diethanolamine	111-42-2		8.8E-01
						Diethyl Phthalate	84-66-2		
		1.0E-04	P			Diethylene Glycol Monobutyl Ether	112-34-5		4.4E-01
		3.0E-04	P			Diethylene Glycol Monoethyl Ether	111-90-0		1.3E+00
						Diethylformamide	617-84-5		
1.0E-01	C					Diethylstilbestrol	56-53-1	1.2E-04	
						Difenzoquat	43222-48-6		
						Diflubenzuron	35367-38-5		
		4.0E+01	I	V		Difluoroethane, 1,1-	75-37-6		1.8E+05
1.3E-05	C			V		Dihydrosafrole	94-58-6	9.4E-01	
		7.0E-01	P	V		Diisopropyl Ether	108-20-3		3.1E+03
				V		Diisopropyl Methylphosphonate	1445-75-6		
						Dimethipin	55290-64-7		
						Dimethoate	60-51-5		
						Dimethoxybenzidine, 3,3'-	119-90-4		
						Dimethyl methylphosphonate	756-79-6		
1.3E-03	C					Dimethylamino azobenzene [p-]	60-11-7	9.4E-03	
						Dimethylaniline HCl, 2,4-	21436-96-4		
						Dimethylaniline, 2,4-	95-68-1		
				V		Dimethylaniline, N,N-	121-69-7		
						Dimethylbenzidine, 3,3'-	119-93-7		
		3.0E-02	I			Dimethylformamide	68-12-2		1.3E+02
		2.0E-06	X			Dimethylhydrazine, 1,1-	57-14-7		8.8E-03
1.6E-01	C					Dimethylhydrazine, 1,2-	540-73-8	7.7E-05	
						Dimethylphenol, 2,4-	105-67-9		
						Dimethylphenol, 2,6-	576-26-1		
						Dimethylphenol, 3,4-	95-65-8		
				V		Dimethylterephthalate	120-61-6		
1.3E-05	C			V		Dimethylvinylchloride	513-37-1	9.4E-01	
						Dinitro-o-cresol, 4,6-	534-52-1		
						Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5		
						Dinitrobenzene, 1,2-	528-29-0		
						Dinitrobenzene, 1,3-	99-65-0		
						Dinitrobenzene, 1,4-	100-25-4		
						Dinitrophenol, 2,4-	51-28-5		
						Dinitrotoluene Mixture, 2,4/2,6-	NA		
8.9E-05	C					Dinitrotoluene, 2,4-	121-14-2	1.4E-01	
						Dinitrotoluene, 2,6-	606-20-2		
						Dinitrotoluene, 2-Amino-4,6-	35572-78-2		
						Dinitrotoluene, 4-Amino-2,6-	19406-51-0		
						Dinitrotoluene, Technical grade	25321-14-6		
						Dinoseb	88-85-7		
7.7E-06	C	1.1E-01	A			Dioxane, 1,4-	123-91-1	1.6E+00	4.8E+02
						Dioxins			
1.3E+00	I					~Hexachlorodibenzo-p-dioxin, Mixture	NA	9.4E-06	
3.8E+01	C	4.0E-08	C			~TCDD, 2,3,7,8-	1746-01-6	3.2E-07	1.8E-04
						Diphenamid	957-51-7		
						Diphenyl Sulfone	127-63-9		
						Diphenylamine	122-39-4		
2.2E-04	I					Diphenylhydrazine, 1,2-	122-66-7	5.6E-02	
						Diquat	85-00-7		
2.1E-03	C					Direct Black 38	1937-37-7	5.8E-03	
2.1E-03	C					Direct Blue 6	2602-46-2	5.8E-03	
1.9E-03	C					Direct Brown 95	16071-86-6	6.5E-03	
						Disulfoton	298-04-4		
				V		Dithiane, 1,4-	505-29-3		
						Diuron	330-54-1		
						Dodine	2439-10-3		
				V		EPTC	759-94-4		
						Endosulfan	115-29-7		
						Endothall	145-73-3		
						Endrin	72-20-8		
1.2E-06	I	1.0E-03	I	V		Epichlorohydrin	106-89-8	1.0E+01	4.4E+00
		2.0E-02	I	V		Epoxybutane, 1,2-	106-88-7		8.8E+01

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Ethephon	16672-87-0		
						Ethion	563-12-2		
		6.0E-02	P			Ethoxyethanol Acetate, 2-	111-15-9		2.6E+02
		2.0E-01	I			Ethoxyethanol, 2-	110-80-5		8.8E+02
				V		Ethyl Acetate	141-78-6		
				V		Ethyl Acrylate	140-88-5		
		1.0E+01	I	V		Ethyl Chloride	75-00-3		4.4E+04
				V		Ethyl Ether	60-29-7		
		3.0E-01	P	V		Ethyl Methacrylate	97-63-2		1.3E+03
						Ethyl-p-nitrophenyl Phosphonate	2104-64-5		
2.5E-06	C	1.0E+00	I	V		Ethylbenzene	100-41-4	4.9E+00	4.4E+03
						Ethylene Cyanohydrin	109-78-4		
						Ethylene Diamine	107-15-3		
		4.0E-01	C			Ethylene Glycol	107-21-1		1.8E+03
		1.6E+00	I			Ethylene Glycol Monobutyl Ether	111-76-2		7.0E+03
8.8E-05	C	3.0E-02	C	V		Ethylene Oxide	75-21-8	1.4E-01	1.3E+02
1.3E-05	C					Ethylene Thiourea	96-45-7	9.4E-01	
1.9E-02	C			V		Ethyleneimine	151-56-4	6.5E-04	
						Ethylphthalyl Ethyl Glycolate	84-72-0		
						Express	101200-48-0		
						Fenamiphos	22224-92-6		
						Fenpropathrin	39515-41-8		
						Fluometuron	2164-17-2		
		1.3E-02	C			Fluoride	16984-48-8		5.7E+01
		1.3E-02	C			Fluorine (Soluble Fluoride)	7782-41-4		5.7E+01
						Fluridone	59756-60-4		
						Flurprimidol	56425-91-3		
						Flutolanil	66332-96-5		
						Fluvalinate	69409-94-5		
						Folpet	133-07-3		
						Fomesafen	72178-02-0		
						Fonofos	944-22-9		
1.3E-05	I	9.8E-03	A			Formaldehyde	50-00-0	9.4E-01	4.3E+01
		3.0E-04	X			Formic Acid	64-18-6		1.3E+00
						Fosetyl-AL	39148-24-8		
						Furans			
				V		~Dibenzofuran	132-64-9		
				V		~Furan	110-00-9		
		2.0E+00	I	V		~Tetrahydrofuran	109-99-9		8.8E+03
						Furazolidone	67-45-8		
		5.0E-02	H			Furfural	98-01-1		2.2E+02
4.3E-04	C					Furium	531-82-8	2.9E-02	
8.6E-06	C					Furmecyclox	60568-05-0	1.4E+00	
						Glufosinate, Ammonium	77182-82-2		
		8.0E-05	C			Glutaraldehyde	111-30-8		3.5E-01
		1.0E-03	H			Glycidyl	765-34-4		4.4E+00
						Glyphosate	1071-83-6		
						Goal	42874-03-3		
		1.0E-02	A			Guthion	86-50-0		4.4E+01
						Haloxyfop, Methyl	69806-40-2		
						Harmony	79277-27-3		
1.3E-03	I					Heptachlor	76-44-8	9.4E-03	
2.6E-03	I					Heptachlor Epoxide	1024-57-3	4.7E-03	
						Hexabromobenzene	87-82-1		
						Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2		
4.6E-04	I					Hexachlorobenzene	118-74-1	2.7E-02	
2.2E-05	I					Hexachlorobutadiene	87-68-3	5.6E-01	
1.8E-03	I					Hexachlorocyclohexane, Alpha-	319-84-6	6.8E-03	
5.3E-04	I					Hexachlorocyclohexane, Beta-	319-85-7	2.3E-02	
3.1E-04	C					Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	4.0E-02	
5.1E-04	I					Hexachlorocyclohexane, Technical	608-73-1	2.4E-02	
		2.0E-04	I			Hexachlorocyclopentadiene	77-47-4		8.8E-01
1.1E-05	C	3.0E-02	I			Hexachloroethane	67-72-1	1.1E+00	1.3E+02
						Hexachlorophene	70-30-4		
						Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4		
		1.0E-05	I	V		Hexamethylene Diisocyanate, 1,6-	822-06-0		4.4E-02
						Hexamethylphosphoramide	680-31-9		
		7.0E-01	I	V		Hexane, N-	110-54-3		3.1E+03
						Hexanedioic Acid	124-04-9		
		3.0E-02	I	V		Hexanone, 2-	591-78-6		1.3E+02
						Hexazinone	51235-04-2		
4.9E-03	I	3.0E-05	P			Hydrazine	302-01-2	2.5E-03	1.3E-01
4.9E-03	I					Hydrazine Sulfate	10034-93-2	2.5E-03	
		2.0E-02	I			Hydrogen Chloride	7647-01-0		8.8E+01
		1.4E-02	C			Hydrogen Fluoride	7664-39-3		6.1E+01

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
		2.0E-03	I			Hydrogen Sulfide	7783-06-4		8.8E+00
						Hydroquinone	123-31-9		
						Imazalil	35554-44-0		
						Imazaquin	81335-37-7		
						Iodine	7553-56-2		
						Iprodione	36734-19-7		
						Iron	7439-89-6		
						Isobutyl Alcohol	78-83-1		
		2.0E+00	C			Isophorone	78-59-1		8.8E+03
						Isopropalin	33820-53-0		
		7.0E+00	C			Isopropanol	67-63-0		3.1E+04
						Isopropyl Methyl Phosphonic Acid	1832-54-8		
						Isoxaben	82558-50-7		
		3.0E-01	A	V		JP-7	NA		1.3E+03
						Kerb	23950-58-5		
						Lactofen	77501-63-4		
						Lead Compounds			
8.0E-05	C					~Lead acetate	301-04-2	1.5E-01	
						~Lead and Compounds	7439-92-1		
1.1E-05	C					~Lead subacetate	1335-32-6	1.1E+00	
						~Tetraethyl Lead	78-00-2		
						Linuron	330-55-2		
						Lithium	7439-93-2		
						Londax	83055-99-6		
						MCPA	94-74-6		
						MCPB	94-81-5		
						MCPP	93-65-2		
						Malathion	121-75-5		
		7.0E-04	C			Maleic Anhydride	108-31-6		3.1E+00
						Maleic Hydrazide	123-33-1		
						Malononitrile	109-77-3		
						Mancozeb	8018-01-7		
						Maneb	12427-38-2		
		5.0E-05	I			Manganese (Diet)	7439-96-5		
		5.0E-05	I			Manganese (Non-diet)	7439-96-5		2.2E-01
						Mephosfolan	950-10-7		
						Mepiquat Chloride	24307-26-4		
						Mercury Compounds			
		3.0E-04	S			~Mercuric Chloride (and other Mercury salts)	7487-94-7		1.3E+00
		3.0E-04	I	V		~Mercury (elemental)	7439-97-6		1.3E+00
						~Methyl Mercury	22967-92-6		
						~Phenylmercuric Acetate	62-38-4		
						Merphos	150-50-5		
						Merphos Oxide	78-48-8		
						Metalaxyl	57837-19-1		
		3.0E-02	P	V		Methacrylonitrile	126-98-7		1.3E+02
						Methamidophos	10265-92-6		
		4.0E+00	C			Methanol	67-56-1		1.8E+04
						Methidathion	950-37-8		
						Methomyl	16752-77-5		
1.4E-05	C					Methoxy-5-nitroaniline, 2-	99-59-2	8.8E-01	
						Methoxychlor	72-43-5		
		1.0E-03	P			Methoxyethanol Acetate, 2-	110-49-6		4.4E+00
		2.0E-02	I			Methoxyethanol, 2-	109-86-4		8.8E+01
				V		Methyl Acetate	79-20-9		
		2.0E-02	P	V		Methyl Acrylate	96-33-3		8.8E+01
		5.0E+00	I	V		Methyl Ethyl Ketone (2-Butanone)	78-93-3		2.2E+04
1.0E-03	X	2.0E-05	X			Methyl Hydrazine	60-34-4	1.2E-02	8.8E-02
		3.0E+00	I	V		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1		1.3E+04
		1.0E-03	C	V		Methyl Isocyanate	624-83-9		4.4E+00
		7.0E-01	I	V		Methyl Methacrylate	80-62-6		3.1E+03
						Methyl Parathion	298-00-0		
						Methyl Phosphonic Acid	993-13-5		
		4.0E-02	H	V		Methyl Styrene (Mixed Isomers)	25013-15-4		1.8E+02
2.8E-05	C					Methyl methanesulfonate	66-27-3	4.4E-01	
2.6E-07	C	3.0E+00	I	V		Methyl tert-Butyl Ether (MTBE)	1634-04-4	4.7E+01	1.3E+04
						Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2		
						Methyl-5-Nitroaniline, 2-	99-55-8		
2.4E-03	C					Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	5.1E-03	
3.7E-05	C					Methylaniline Hydrochloride, 2-	636-21-5	3.3E-01	
						Methylarsonic acid	124-58-3		
						Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7		
						Methylbenzene-1,4-diamine sulfate, 2-	615-50-9		
6.3E-03	C				M	Methylcholanthrene, 3-	56-49-5	1.9E-03	
1.0E-08	I	6.0E-01	I	V	M	Methylene Chloride	75-09-2	1.2E+03	2.6E+03

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
4.3E-04	C				M	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.9E-02	
1.3E-05	C					Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	9.4E-01	
4.6E-04	C	2.0E-02	C			Methylenebisbenzenamine, 4,4'-	101-77-9	2.7E-02	8.8E+01
		6.0E-04	I			Methylenediphenyl Diisocyanate	101-68-8		2.6E+00
				V		Methylstyrene, Alpha-	98-83-9		
						Metolachlor	51218-45-2		
						Metribuzin	21087-64-9		
				V		Mineral oils	8012-95-1		
5.1E-03	C					Mirex	2385-85-5	2.4E-03	
						Molinate	2212-67-1		
						Molybdenum	7439-98-7		
						Monochloramine	10599-90-3		
						Monomethylaniline	100-61-8		
						N,N'-Diphenyl-1,4-benzenediamine	74-31-7		
						Naled	300-76-5		
		1.0E-01	P	V		Naphtha, High Flash Aromatic (HFAN)	64724-95-6		4.4E+02
0.0E+00	C					Naphthylamine, 2-	91-59-8		
						Napropamide	15299-99-7		
		1.4E-05	C			Nickel Carbonyl	13463-39-3		6.1E-02
		2.0E-05	C			Nickel Oxide	1313-99-1		8.8E-02
2.4E-04	I	1.4E-05	C			Nickel Refinery Dust	NA	5.1E-02	6.1E-02
2.6E-04	C	9.0E-05	A			Nickel Soluble Salts	7440-02-0	4.7E-02	3.9E-01
4.8E-04	I	1.4E-05	C			Nickel Subsulfide	12035-72-2	2.6E-02	6.1E-02
						Nitrate	14797-55-8		
						Nitrate + Nitrite (as N)	NA		
						Nitrite	14797-65-0		
		5.0E-05	X			Nitroaniline, 2-	88-74-4		2.2E-01
		6.0E-03	P			Nitroaniline, 4-	100-01-6		2.6E+01
4.0E-05	I	9.0E-03	I	V		Nitrobenzene	98-95-3	3.1E-01	3.9E+01
						Nitrocellulose	9004-70-0		
						Nitrofurantoin	67-20-9		
3.7E-04	C					Nitrofurazone	59-87-0	3.3E-02	
						Nitroglycerin	55-63-0		
						Nitroguanidine	556-88-7		
9.0E-06	P	2.0E-02	P	V		Nitromethane	75-52-5	1.4E+00	8.8E+01
2.7E-03	H	2.0E-02	I	V		Nitropropane, 2-	79-46-9	4.5E-03	8.8E+01
7.7E-03	C				M	Nitroso-N-ethylurea, N-	759-73-9	1.6E-03	
3.4E-02	C				M	Nitroso-N-methylurea, N-	684-93-5	3.6E-04	
1.6E-03	I			V		Nitroso-di-N-butylamine, N-	924-16-3	7.7E-03	
2.0E-03	C					Nitroso-di-N-propylamine, N-	621-64-7	6.1E-03	
8.0E-04	C					Nitrosodiethanolamine, N-	1116-54-7	1.5E-02	
4.3E-02	I				M	Nitrosodiethylamine, N-	55-18-5	2.9E-04	
1.4E-02	I	4.0E-05	X		M	Nitrosodimethylamine, N-	62-75-9	8.8E-04	1.8E-01
2.6E-06	C					Nitrosodiphenylamine, N-	86-30-6	4.7E+00	
6.3E-03	C					Nitrosomethylethylamine, N-	10595-95-6	1.9E-03	
1.9E-03	C					Nitrosomorpholine [N-]	59-89-2	6.5E-03	
2.7E-03	C					Nitrosopiperidine [N-]	100-75-4	4.5E-03	
6.1E-04	I					Nitrosopyrrolidine, N-	930-55-2	2.0E-02	
						Nitrotoluene, m-	99-08-1		
				V		Nitrotoluene, o-	88-72-2		
						Nitrotoluene, p-	99-99-0		
		2.0E-01	P	V		Nonane, n-	111-84-2		8.8E+02
						Norflurazon	27314-13-2		
						Nustar	85509-19-9		
						Octabromodiphenyl Ether	32536-52-0		
						Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0		
						Octamethylpyrophosphoramide	152-16-9		
						Octyl Phthalate, di-N-	117-84-0		
						Oryzalin	19044-88-3		
						Oxadiazon	19666-30-9		
						Oxamyl	23135-22-0		
						Paclobutrazol	76738-62-0		
						Paraquat Dichloride	1910-42-5		
						Parathion	56-38-2		
						Pebulate	1114-71-2		
						Pendimethalin	40487-42-1		
						Pentabromodiphenyl Ether	32534-81-9		
						Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9		
						Pentachlorobenzene	608-93-5		
						Pentachloroethane	76-01-7		
						Pentachloronitrobenzene	82-68-8		
5.1E-06	C					Pentachlorophenol	87-86-5	2.4E+00	
						Pentaerythritol tetranitrate (PETN)	78-11-5		
		1.0E+00	P	V		Pentane, n-	109-66-0		4.4E+03
						Perchlorates			

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						~Ammonium Perchlorate	7790-98-9		
						~Lithium Perchlorate	7791-03-9		
						~Perchlorate and Perchlorate Salts	14797-73-0		
						~Potassium Perchlorate	7778-74-7		
						~Sodium Perchlorate	7601-89-0		
						Permethrin	52645-53-1		
6.3E-07	C					Phenacetin	62-44-2	1.9E+01	
						Phenmedipham	13684-63-4		
		2.0E-01	C			Phenol	108-95-2		8.8E+02
						Phenothiazine	92-84-2		
						Phenylenediamine, m-	108-45-2		
						Phenylenediamine, o-	95-54-5		
						Phenylenediamine, p-	106-50-3		
						Phenylphenol, 2-	90-43-7		
						Phorate	298-02-2		
		3.0E-04	I	V		Phosgene	75-44-5		1.3E+00
						Phosmet	732-11-6		
						Phosphates, Inorganic			
						~Aluminum metaphosphate	13776-88-0		
						~Ammonium polyphosphate	68333-79-9		
						~Calcium pyrophosphate	7790-76-3		
						~Diammonium phosphate	7783-28-0		
						~Dicalcium phosphate	7757-93-9		
						~Dimagnesium phosphate	7782-75-4		
						~Dipotassium phosphate	7758-11-4		
						~Disodium phosphate	7558-79-4		
						~Monoaluminum phosphate	13530-50-2		
						~Monoammonium phosphate	7722-76-1		
						~Monocalcium phosphate	7758-23-8		
						~Monomagnesium phosphate	7757-86-0		
						~Monopotassium phosphate	7778-77-0		
						~Monosodium phosphate	7558-80-7		
						~Polyphosphoric acid	8017-16-1		
						~Potassium tripolyphosphate	13845-36-8		
						~Sodium acid pyrophosphate	7758-16-9		
						~Sodium aluminum phosphate (acidic)	7785-88-8		
						~Sodium aluminum phosphate (anhydrous)	10279-59-1		
						~Sodium aluminum phosphate (tetrahydrate)	10305-76-7		
						~Sodium hexametaphosphate	10124-56-8		
						~Sodium polyphosphate	68915-31-1		
						~Sodium trimetaphosphate	7785-84-4		
						~Sodium tripolyphosphate	7758-29-4		
						~Tetrapotassium phosphate	7320-34-5		
						~Tetrasodium pyrophosphate	7722-88-5		
						~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5		
						~Tricalcium phosphate	7758-87-4		
						~Trimagnesium phosphate	7757-87-1		
						~Tripotassium phosphate	7778-53-2		
						~Trisodium phosphate	7601-54-9		
		3.0E-04	I			Phosphine	7803-51-2		1.3E+00
		1.0E-02	I			Phosphoric Acid	7664-38-2		4.4E+01
						Phosphorus, White	7723-14-0		
						Phthalic Acid, P-	100-21-0		
		2.0E-02	C			Phthalic Anhydride	85-44-9		8.8E+01
						Picloram	1918-02-1		
						Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3		
						Pirimiphos, Methyl	29232-93-7		
8.6E-03	C					Polybrominated Biphenyls	59536-65-1	1.4E-03	
						Polychlorinated Biphenyls (PCBs)			
2.0E-05	S					~Aroclor 1016	12674-11-2	6.1E-01	
5.7E-04	S			V		~Aroclor 1221	11104-28-2	2.1E-02	
5.7E-04	S			V		~Aroclor 1232	11141-16-5	2.1E-02	
5.7E-04	S					~Aroclor 1242	53469-21-9	2.1E-02	
5.7E-04	S					~Aroclor 1248	12672-29-6	2.1E-02	
5.7E-04	S					~Aroclor 1254	11097-69-1	2.1E-02	
5.7E-04	S					~Aroclor 1260	11096-82-5	2.1E-02	
1.1E-03	E	1.3E-03	E			~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.1E-02	5.8E+00
1.1E+00	E	1.3E-06	E			~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.1E-05	5.8E-03
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.1E-02	5.8E+00
1.1E-03	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.1E-02	5.8E+00

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IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
3.8E+00	E	4.0E-07	E			~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	3.2E-06	1.8E-03
5.7E-04	I					~Polychlorinated Biphenyls (high risk)	1336-36-3	2.1E-02	
1.0E-04	I					~Polychlorinated Biphenyls (low risk)	1336-36-3	1.2E-01	
2.0E-05	I					~Polychlorinated Biphenyls (lowest risk)	1336-36-3	6.1E-01	
3.8E-03	E	4.0E-04	E			~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	3.2E-03	1.8E+00
1.1E-02	E	1.3E-04	E			~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.1E-03	5.8E-01
		6.0E-04	I			Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9		2.6E+00
						Polynuclear Aromatic Hydrocarbons (PAHs)			
				V		~Acenaphthene	83-32-9		
				V		~Anthracene	120-12-7		
1.1E-04	C				M	~Benz[a]anthracene	56-55-3	1.1E-01	
1.1E-04	C					~Benzo(j)fluoranthene	205-82-3	1.1E-01	
1.1E-03	C				M	~Benzo[a]pyrene	50-32-8	1.1E-02	
1.1E-04	C				M	~Benzo[b]fluoranthene	205-99-2	1.1E-01	
1.1E-04	C				M	~Benzo[k]fluoranthene	207-08-9	1.1E-01	
1.1E-05	C				M	~Chrysene	218-01-9	1.1E+00	
1.2E-03	C				M	~Dibenz[a,h]anthracene	53-70-3	1.0E-02	
1.1E-03	C					~Dibenzo(a,e)pyrene	192-65-4	1.1E-02	
7.1E-02	C				M	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	1.7E-04	
						~Fluoranthene	206-44-0		
				V		~Fluorene	86-73-7		
1.1E-04	C				M	~Indeno[1,2,3-cd]pyrene	193-39-5	1.1E-01	
				V		~Methylnaphthalene, 1-	90-12-0		
				V		~Methylnaphthalene, 2-	91-57-6		
3.4E-05	C	3.0E-03	I	V		~Naphthalene	91-20-3	3.6E-01	1.3E+01
1.1E-04	C					~Nitropyrene, 4-	57835-92-4	1.1E-01	
				V		~Pyrene	129-00-0		
						Prochloraz	67747-09-5		
						Profluralin	26399-36-0		
						Prometon	1610-18-0		
						Prometryn	7287-19-6		
						Propachlor	1918-16-7		
						Propanil	709-98-8		
						Propargite	2312-35-8		
						Propargyl Alcohol	107-19-7		
						Propazine	139-40-2		
						Propham	122-42-9		
						Propiconazole	60207-90-1		
		8.0E-03	I	V		Propionaldehyde	123-38-6		3.5E+01
		1.0E+00	X	V		Propyl benzene	103-65-1		4.4E+03
		3.0E+00	C	V		Propylene	115-07-1		1.3E+04
						Propylene Glycol	57-55-6		
		2.7E-04	A			Propylene Glycol Dinitrate	6423-43-4		1.2E+00
						Propylene Glycol Monoethyl Ether	1569-02-4		
		2.0E+00	I			Propylene Glycol Monomethyl Ether	107-98-2		8.8E+03
3.7E-06	I	3.0E-02	I	V		Propylene Oxide	75-56-9	3.3E+00	1.3E+02
						Pursuit	81335-77-5		
						Pydrin	51630-58-1		
				V		Pyridine	110-86-1		
						Quinalphos	13593-03-8		
						Quinoline	91-22-5		
		3.0E-02	A			Refractory Ceramic Fibers	NA		1.3E+02
						Resmethrin	10453-86-8		
						Ronnel	299-84-3		
						Rotenone	83-79-4		
6.3E-05	C				M	Safrole	94-59-7	1.9E-01	
						Savey	78587-05-0		
						Selenious Acid	7783-00-8		
		2.0E-02	C			Selenium	7782-49-2		8.8E+01
		2.0E-02	C			Selenium Sulfide	7446-34-6		8.8E+01
						Sethoxydim	74051-80-2		
		3.0E-03	C			Silica (crystalline, respirable)	7631-86-9		1.3E+01
						Silver	7440-22-4		
						Simazine	122-34-9		
						Sodium Acifluorfen	62476-59-9		
						Sodium Azide	26628-22-8		
						Sodium Diethyldithiocarbamate	148-18-5		
		1.3E-02	C			Sodium Fluoride	7681-49-4		5.7E+01
						Sodium Fluoroacetate	62-74-8		
						Sodium Metavanadate	13718-26-8		
						Stirofos (Tetrachlorovinphos)	961-11-5		
						Strontium, Stable	7440-24-6		
						Strychnine	57-24-9		
		1.0E+00	I	V		Styrene	100-42-5		4.4E+03
		2.0E-03	P			Sulfolane	126-33-0		8.8E+00

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
		1.0E-03	C			Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9		
						Sulfuric Acid	7664-93-9		4.4E+00
						Systhane	88671-89-0		
						TCMTB	21564-17-0		
						Tebuthiuron	34014-18-1		
						Temephos	3383-96-8		
						Terbacil	5902-51-2		
						Terbufos	13071-79-9		
						Terbutryn	886-50-0		
						Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1		
						Tetrachlorobenzene, 1,2,4,5-	95-94-3		
7.4E-06	I			V		Tetrachloroethane, 1,1,1,2-	630-20-6	1.7E+00	
5.8E-05	C			V		Tetrachloroethane, 1,1,2,2-	79-34-5	2.1E-01	
2.6E-07	I	4.0E-02	I	V		Tetrachloroethylene	127-18-4	4.7E+01	1.8E+02
						Tetrachlorophenol, 2,3,4,6-	58-90-2		
						Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1		
						Tetraethyl Dithiopyrophosphate	3689-24-5		
		8.0E+01	I	V		Tetrafluoroethane, 1,1,1,2-	811-97-2		3.5E+05
						Tetryl (Trinitrophenylmethylnitramine)	479-45-8		
						Thallium (I) Nitrate	10102-45-1		
						Thallium (Soluble Salts)	7440-28-0		
						Thallium Acetate	563-68-8		
						Thallium Carbonate	6533-73-9		
						Thallium Chloride	7791-12-0		
						Thallium Sulfate	7446-18-6		
						Thiobencarb	28249-77-6		
						Thiodiglycol	111-48-8		
						Thiofanox	39196-18-4		
						Thiophanate, Methyl	23564-05-8		
						Thiram	137-26-8		
						Tin	7440-31-5		
		1.0E-04	A			Titanium Tetrachloride	7550-45-0		4.4E-01
		5.0E+00	I	V		Toluene	108-88-3		2.2E+04
						Toluene-2,5-diamine	95-70-5		
						Toluidine, p-	106-49-0		
3.2E-04	I					Toxaphene	8001-35-2	3.8E-02	
						Tralomethrin	66841-25-6		
						Tri-n-butyltin	688-73-3		
						Triacetin	102-76-1		
						Triallate	2303-17-5		
						Triasulfuron	82097-50-5		
						Tribromobenzene, 1,2,4-	615-54-3		
						Tributyl Phosphate	126-73-8		
						Tributyltin Compounds	NA		
						Tributyltin Oxide	56-35-9		
		3.0E+01	H	V		Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1		1.3E+05
						Trichloroacetic Acid	76-03-9		
						Trichloroaniline HCl, 2,4,6-	33663-50-2		
						Trichloroaniline, 2,4,6-	634-93-5		
				V		Trichlorobenzene, 1,2,3-	87-61-6		
		2.0E-03	P	V		Trichlorobenzene, 1,2,4-	120-82-1		8.8E+00
		5.0E+00	I	V		Trichloroethane, 1,1,1-	71-55-6		2.2E+04
1.6E-05	I	2.0E-04	X	V		Trichloroethane, 1,1,2-	79-00-5	7.7E-01	8.8E-01
4.1E-06	I	2.0E-03	I	V	M	Trichloroethylene	79-01-6	3.0E+00	8.8E+00
		7.0E-01	H	V		Trichlorofluoromethane	75-69-4		3.1E+03
						Trichlorophenol, 2,4,5-	95-95-4		
3.1E-06	I					Trichlorophenol, 2,4,6-	88-06-2	4.0E+00	
						Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5		
						Trichlorophenoxypropionic acid, -2,4,5	93-72-1		
				V		Trichloropropane, 1,1,2-	598-77-6		
		3.0E-04	I	V	M	Trichloropropane, 1,2,3-	96-18-4		1.3E+00
		3.0E-04	P	V		Trichloropropene, 1,2,3-	96-19-5		1.3E+00
						Tricresyl Phosphate (TCP)	1330-78-5		
						Tridiphane	58138-08-2		
		7.0E-03	I	V		Triethylamine	121-44-8		3.1E+01
						Trifluralin	1582-09-8		
						Trimethyl Phosphate	512-56-1		
		5.0E-03	P	V		Trimethylbenzene, 1,2,3-	526-73-8		2.2E+01
		7.0E-03	P	V		Trimethylbenzene, 1,2,4-	95-63-6		3.1E+01
				V		Trimethylbenzene, 1,3,5-	108-67-8		
						Trinitrobenzene, 1,3,5-	99-35-4		
						Trinitrotoluene, 2,4,6-	118-96-7		
						Triphenylphosphine Oxide	791-28-6		
						Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8		
						Tris(1-chloro-2-propyl)phosphate	13674-84-5		

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Toxicity and Chemical-specific Information						Contaminant		Carcinogenic Target Risk (TR) = 1E-06	Noncancer Hazard Index (HI) = 1
IUR ($(ug/m^3)^{-1}$)	key	RfC_i (mg/m^3)	key	voc	mutagen	Analyte	CAS No.	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)
						Tris(2-chloroethyl)phosphate	115-96-8		
						Tris(2-ethylhexyl)phosphate	78-42-2		
		4.0E-05	A			Uranium (Soluble Salts)	NA		1.8E-01
2.9E-04	C				M	Urethane	51-79-6	4.2E-02	
8.3E-03	P	7.0E-06	P			Vanadium Pentoxide	1314-62-1	1.5E-03	3.1E-02
		1.0E-04	A			Vanadium and Compounds	7440-62-2		4.4E-01
						Vernolate	1929-77-7		
						Vinclozolin	50471-44-8		
		2.0E-01	I	V		Vinyl Acetate	108-05-4		8.8E+02
3.2E-05	H	3.0E-03	I	V		Vinyl Bromide	593-60-2	3.8E-01	1.3E+01
4.4E-06	I	1.0E-01	I	V	M	Vinyl Chloride	75-01-4	2.8E+00	4.4E+02
						Warfarin	81-81-2		
		1.0E-01	S	V		Xylene, P-	106-42-3		4.4E+02
		1.0E-01	S	V		Xylene, m-	108-38-3		4.4E+02
		1.0E-01	S	V		Xylene, o-	95-47-6		4.4E+02
		1.0E-01	I	V		Xylenes	1330-20-7		4.4E+02
						Zinc Phosphide	1314-84-7		
						Zinc and Compounds	7440-66-6		
						Zineb	12122-67-7		
						Zirconium	7440-67-7		

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
1.8E-02	C	5.1E-06	C	1.5E-01	I					1	-1.5	1	Yes	ALAR	1596-84-5	3.7E+00	1.1E+04		3.7E+00	2.3E+03	7.1E+06		2.3E+03	
8.7E-03	I			4.0E-03	I					1	-0.85	1	Yes	Acephate	30560-19-1	7.7E+00	1.0E+04		7.7E+00	6.3E+01	8.1E+04		6.3E+01	
		2.2E-06	I			9.0E-03	I	V		1	-0.34	1	Yes	Acetaldehyde	75-07-0			2.2E+00	2.2E+00			1.9E+01	1.9E+01	
				2.0E-02	I					1	3.03	0.9	Yes	Acetochlor	34256-82-1					3.1E+02	2.1E+03		2.7E+02	
				9.0E-01	I	3.1E+01	A	V		1	-0.24	1	Yes	Acetone	67-64-1					1.4E+04	2.9E+06	6.4E+04	1.2E+04	
						2.0E-03	X	V		1	-0.03	1	Yes	Acetone Cyanohydrin	75-86-5							4.2E+00	4.2E+00	
						6.0E-02	I	V		1	-0.34	1	Yes	Acetonitrile	75-05-8							1.3E+02	1.3E+02	
				1.0E-01	I			V		1	1.58	1	Yes	Acetophenone	98-86-2					1.6E+03	3.3E+04		1.5E+03	
3.8E+00	C	1.3E-03	C							1	3.12	1	Yes	Acetylaminofluorene, 2-	53-96-3	1.8E-02	5.7E-02		1.3E-02					
				5.0E-04	I	2.0E-05	I	V		1	-0.01	1	Yes	Acrolein	107-02-8					7.8E+00	1.1E+03	4.2E-02	4.1E-02	
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	1	-0.67	1	Yes	Acrylamide	79-06-1	4.3E-02	2.2E+01		4.3E-02	3.1E+01	1.4E+04		3.1E+01	
				5.0E-01	I	1.0E-03	I			1	0.35	1	Yes	Acrylic Acid	79-10-7					7.8E+03	7.4E+05		7.7E+03	
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		1	0.25	1	Yes	Acrylonitrile	107-13-1	1.2E-01	1.2E+01	7.2E-02	4.5E-02	6.3E+02	5.8E+04	4.2E+00	4.1E+00	
						6.0E-03	P			1	-0.32	1	Yes	Adiponitrile	111-69-3									
5.6E-02	C			1.0E-02	I					1	3.52	0.9	Yes	Alachlor	15972-60-8	1.2E+00	3.8E+00		9.1E-01	1.6E+02	4.9E+02		1.2E+02	2.0E+00
				1.0E-03	I					1	1.13	1	Yes	Aldicarb	116-06-3					1.6E+01	1.0E+03		1.5E+01	3.0E+00
				1.0E-03	I					1	-0.57	1	Yes	Aldicarb Sulfone	1646-88-4					1.6E+01	1.7E+04		1.6E+01	2.0E+00
										1	-0.78	1	Yes	Aldicarb sulfoxide	1646-87-3									4.0E+00
1.7E+01	I	4.9E-03	I	3.0E-05	I					1	6.5	1	No	Aldrin	309-00-2	4.0E-03			4.0E-03	4.7E-01			4.7E-01	
				2.5E-01	I					1	2.2	1	Yes	Ally	74223-64-6					3.9E+03	1.7E+05		3.8E+03	
				5.0E-03	I	1.0E-04	X			1	0.17	1	Yes	Allyl Alcohol	107-18-6					7.8E+01	8.6E+03		7.8E+01	
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1	1.93	1	Yes	Allyl Chloride	107-05-1	3.2E+00	2.9E+01	8.1E-01	6.3E-01			2.1E+00	2.1E+00	
				1.0E+00	P	5.0E-03	P			1		1	Yes	Aluminum	7429-90-5					1.6E+04	2.4E+06		1.6E+04	
				4.0E-04	I					1		1	Yes	Aluminum Phosphide	20859-73-8					6.3E+00	9.5E+02		6.2E+00	
				3.0E-04	I					1	2.31	1	Yes	Amdro	67485-29-4					4.7E+00	3.6E+02		4.6E+00	
				9.0E-03	I					1	2.98	1	Yes	Ametryn	834-12-8					1.4E+02	6.9E+02		1.2E+02	
2.1E+01	C	6.0E-03	C							1	2.86	1	Yes	Aminobiphenyl, 4-	92-67-1	3.2E-03	1.3E-02		2.6E-03					
				8.0E-02	P					1	0.21	1	Yes	Aminophenol, m-	591-27-5					1.3E+03	2.0E+05		1.2E+03	
				2.0E-02	P					1	0.04	1	Yes	Aminophenol, p-	123-30-8					3.1E+02	6.4E+04		3.1E+02	
				2.5E-03	I					1	5.5	0.9	Yes	Amitraz	33089-61-1					3.9E+01	6.9E+00		5.9E+00	
						1.0E-01	I			1				Ammonia	7664-41-7									
				2.0E-01	I					1		1	Yes	Ammonium Sulfamate	7773-06-0					3.1E+03	4.7E+05		3.1E+03	
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			1	0.9	1	Yes	Aniline	62-53-3	1.2E+01	5.9E+02		1.2E+01	1.1E+02	5.3E+03		1.1E+02	
4.0E-02	P			2.0E-03	X					1	3.39	0.9	Yes	Anthraquinone, 9,10-	84-65-1	1.7E+00	4.3E+00		1.2E+00	3.1E+01	8.1E+01		2.3E+01	
				4.0E-04	I					0.15		1	Yes	Antimony (metallic)	7440-36-0					6.3E+00	1.4E+02		6.0E+00	6.0E+00
				5.0E-04	H					0.15		1	Yes	Antimony Pentoxide	1314-60-9					7.8E+00	1.8E+02		7.5E+00	
				9.0E-04	H					0.15		0.9	Yes	Antimony Potassium Tartrate	11071-15-1					1.4E+01	3.2E+02		1.3E+01	
				4.0E-04	H					0.15		1	Yes	Antimony Tetroxide	1332-81-6					6.3E+00	1.4E+02		6.0E+00	
						2.0E-04	I			0.15		1	Yes	Antimony Trioxide	1309-64-4									
				1.3E-02	I					1	3.1	0.9	Yes	Apollo	74115-24-5					2.0E+02	1.5E+03		1.8E+02	
2.5E-02	I	7.1E-06	I	5.0E-02	H					1	4.82	0.8	Yes	Aramite	140-57-8	2.7E+00	2.0E+00		1.1E+00	7.8E+02	5.8E+02		3.3E+02	
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			1		1	Yes	Arsenic, Inorganic	7440-38-2	4.5E-02	8.3E+00		4.5E-02	4.7E+00	7.1E+02		4.7E+00	1.0E+01
				3.5E-06	C	5.0E-05	I			1		1	Yes	Arsine	7784-42-1					5.5E-02	8.3E+00		5.4E-02	
				9.0E-03	I					1	4.28	0.9	Yes	Assure	76578-14-8					1.4E+02	2.7E+02		9.3E+01	
				5.0E-02	I					1	-0.27	1	Yes	Asulam	3337-71-1					7.8E+02	5.7E+05		7.8E+02	
2.3E-01	C			3.5E-02	I					1	2.61	1	Yes	Atrazine	1912-24-9	2.9E-01	2.3E+00		2.6E-01	5.5E+02	4.4E+03		4.9E+02	3.0E+00
8.8E-01	C	2.5E-04	C							1	2.98	0.9	Yes	Auramine	492-80-8	7.6E-02	2.3E-01		5.7E-02					
				4.0E-04	I					1	4.48	1	No	Avermectin B1	65195-55-3					6.3E+00			6.3E+00	
1.1E-01	I	3.1E-05	I					V		1	3.82	1	Yes	Azobenzene	103-33-3	6.1E-01	6.2E-01	1.6E-01	1.0E-01					
				2.0E-01	I	5.0E-04	H			0.07		1	Yes	Barium	7440-39-3					3.1E+03	3.3E+04		2.9E+03	2.0E+03
				4.0E-03	I					1	1.52	1	Yes	Baygon	114-26-1					6.3E+01	2.6E+03		6.1E+01	
				3.0E-02	I					1	2.77	1	Yes	Bayleton	43121-43-3					4.7E+02	4.9E+03		4.3E+02	
				2.5E-02	I					1	5.95	0.7	Yes	Baythroid	68359-37-5					3.9E+02	1.1E+02		8.7E+01	
				3.0E-01	I					1	5.29	0.8	Yes	Benefin	1861-40-1					4.7E+03	1.7E+03		1.2E+03	
				5.0E-02	I					1	2.12	1	Yes	Benomyl	17804-35-2					7.8E+02	2.2E+04		7.5E+02	
				3.0E-02	I					1	2.34	1	Yes	Bentazon	25057-89-0					4.7E+02	6.7E+03		4.4E+02	
				1.0E-01	I			V		1	1.48	1	Yes	Benzaldehyde	100-52-7					1.6E+03	3.4E+04		1.5E+03	
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1	2.13	1	Yes	Benzene	71-43-2	1.2E+00	8.4E+00	6.2E-01	3.9E-01	6.3E+01	4.1E+02	6.3E+01	2.9E+01	5.0E+00
1.0E-01	X			3.0E-04	X					1	-3.727	1	No	Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	6.7E-01			6.7E-01	4.7E+00			4.7E+00	
				1.0E-03	P			V		1	2.52	1	Yes	Benzenethiol	108-98-5					1.6E+01	7.3E+01		1.3E+01	
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1	1.34	1	Yes	Benzidine	92-87-5	9.4E-05	4.6E-03		9.2E-05	4.7E+01	2.1E+03		4.6E+01	
				4.0E+00	I					1	1.87	1	Yes	Benzoic Acid	65-85-0					6.3E+04	8.5E+05		5.8E+04	
1.3E+01	I							V		1	3.9	1	Yes	Benzotrichloride	98-07-7	5.2E-03	5.1E-03		2.6E-03					
				1.0E-01	P					1	1.1	1	Yes	Benzyl Alcohol	100-51-6					1.6E+03	6.3E+04		1.5E+03	
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1	2.3	1	Yes	Benzyl Chloride	100-44-7	4.0E-01	2.9E+00	9.9E-02	7.7E-02	3.1E+01	2.3E+02	2.1E+00	1.9E+00	

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
		2.4E-03	I	2.0E-03	I	2.0E-05	I			0.007		1	Yes	Beryllium and compounds	7440-41-7					3.1E+01	3.3E+01		1.6E+01	4.0E+00
				1.0E-04	I					1	0	1	Yes	Bidrin	141-66-2					1.6E+00	7.8E+02		1.6E+00	
				9.0E-03	P					1	4.48	0.9	Yes	Bifenox	42576-02-3					1.4E+02	1.6E+02		7.5E+01	
				1.5E-02	I					1	8.15	0	No	Biphenthrin	82657-04-3					2.3E+02			2.3E+02	
8.0E-03	X			5.0E-02	I	4.0E-04	X	V		1	3.98	1	Yes	Biphenyl, 1,1'-	92-52-4	8.4E+00	5.6E+00		3.3E+00	7.8E+02	5.2E+02	8.3E-01	8.3E-01	
7.0E-02	H	1.0E-05	H	4.0E-02	I			V		1	2.48	1	Yes	Bis(2-chloro-1-methylethyl) ether	108-60-1	9.6E-01	7.0E+00	4.9E-01	3.1E-01	6.3E+02	4.6E+03		5.5E+02	
				3.0E-03	P					1	1.3	1	Yes	Bis(2-chloroethoxy)methane	111-91-1					4.7E+01	2.1E+03		4.6E+01	
1.1E+00	I	3.3E-04	I					V		1	1.29	1	Yes	Bis(2-chloroethyl)ether	111-44-4	6.1E-02	2.3E+00	1.5E-02	1.2E-02					
1.4E-02	I	2.4E-06	C	2.0E-02	I					1	7.6	0.8	No	Bis(2-ethylhexyl)phthalate	117-81-7	4.8E+00			4.8E+00	3.1E+02			3.1E+02	6.0E+00
2.2E+02	I	6.2E-02	I					V		1	0.57	1	Yes	Bis(chloromethyl)ether	542-88-1	3.1E-04	2.9E-02	7.8E-05	6.2E-05					
				5.0E-02	I					1	3.32	1	Yes	Bisphenol A	80-05-7					7.8E+02	2.3E+03		5.8E+02	
				2.0E-01	I	2.0E-02	H			1		1	Yes	Boron And Borates Only	7440-42-8					3.1E+03	4.7E+05		3.1E+03	
				2.0E+00	P	2.0E-02	P			1		1	Yes	Boron Trichloride	10294-34-5					3.1E+04	4.7E+06		3.1E+04	
				4.0E-02	C	1.3E-02	C			1		1	Yes	Boron Trifluoride	7637-07-2					6.3E+02	9.5E+04		6.2E+02	
7.0E-01	I			4.0E-03	I					1		1	Yes	Bromate	15541-45-4	9.6E-02	1.8E+01		9.6E-02	6.3E+01	9.5E+03		6.2E+01	1.0E+01
2.0E+00	X	6.0E-04	X					V		1	1.92	1	Yes	Bromo-2-chloroethane, 1-	107-04-0	3.4E-02	4.8E-01	8.1E-03	6.4E-03					
				8.0E-03	I	6.0E-02	I	V		1	2.99	1	Yes	Bromobenzene	108-86-1					1.3E+02	3.8E+02	1.3E+02	5.4E+01	
						4.0E-02	X	V		1	1.41	1	Yes	Bromochloromethane	74-97-5							8.3E+01	8.3E+01	
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		1	2	1	Yes	Bromodichloromethane	75-27-4	1.1E+00	1.6E+01	1.3E-01	1.2E-01	3.1E+02	4.6E+03		2.9E+02	8.0E+01(F)
7.9E-03	I	1.1E-06	I	2.0E-02	I					1	2.4	1	Yes	Bromoform	75-25-2	8.5E+00	1.2E+02		7.9E+00	3.1E+02	4.4E+03		2.9E+02	8.0E+01(F)
				1.4E-03	I	5.0E-03	I	V		1	1.19	1	Yes	Bromomethane	74-83-9					2.2E+01	6.8E+02	1.0E+01	7.0E+00	
				5.0E-03	H					1	5.21	0.8	Yes	Bromophos	2104-96-3					7.8E+01	3.9E+01		2.6E+01	
				2.0E-02	I					1	3.39	0.9	Yes	Bromoxynil	1689-84-5					3.1E+02	1.3E+03		2.5E+02	
				2.0E-02	I					1	5.4	0.8	Yes	Bromoxynil Octanoate	1689-99-2					3.1E+02	1.5E+02		1.0E+02	
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1	1.99	1	Yes	Butadiene, 1,3-	106-99-0	2.0E-02	1.4E-01	1.6E-01	1.6E-02			4.2E+00	4.2E+00	
				1.0E-01	I					1	0.88	1	Yes	Butanol, N-	71-36-3					1.6E+03	6.6E+04		1.5E+03	
1.9E-03	P			2.0E-01	I					1	4.73	0.9	Yes	Butyl Benzyl Phthlate	85-68-7	3.5E+01	2.3E+01		1.4E+01	3.1E+03	2.0E+03		1.2E+03	
				2.0E+00	P	3.0E+01	P			1	0.61	1	Yes	Butyl alcohol, sec-	78-92-2					3.1E+04	2.0E+06		3.1E+04	
				5.0E-02	I					1	4.15	1	Yes	Butylate	2008-41-5					7.8E+02	6.0E+02		3.4E+02	
2.0E-04	C	5.7E-08	C							1	3.5	1	Yes	Butylated hydroxyanisole	25013-16-5	3.4E+02	5.5E+02		2.1E+02					
				5.0E-02	P			V		1	4.38	1	No	Butylbenzene, n-	104-51-8					7.8E+02			7.8E+02	
				1.0E-01	X			V		1	4.57	1	No	Butylbenzene, sec-	135-98-8					1.6E+03			1.6E+03	
				1.0E-01	X			V		1	4.11	1	Yes	Butylbenzene, tert-	98-06-6					1.6E+03	7.5E+02		5.1E+02	
				1.0E+00	I					1	4.15	0.9	Yes	Butylphthalyl Butylglycolate	85-70-1					1.6E+04	2.9E+04		1.0E+04	
				2.0E-02	A					1	0.365	1	Yes	Cacodylic Acid	75-60-5					3.1E+02	4.7E+04		3.1E+02	
		1.8E-03	I	1.0E-03	I	1.0E-05	A			0.025				Cadmium (Diet)	7440-43-9									
		1.8E-03	I	5.0E-04	I	1.0E-05	A			0.05		1	Yes	Cadmium (Water)	7440-43-9					7.8E+00	5.9E+01		6.9E+00	5.0E+00
				5.0E-01	I					1	-0.19	1	Yes	Caprolactam	105-60-2					7.8E+03	6.4E+05		7.7E+03	
1.5E-01	C	4.3E-05	C	2.0E-03	I					1	3.8	0.9	Yes	Captafol	2425-06-1	4.5E-01	1.5E+00		3.5E-01	3.1E+01	1.1E+02		2.4E+01	
2.3E-03	C	6.6E-07	C	1.3E-01	I					1	2.8	1	Yes	Captan	133-06-2	2.9E+01	3.0E+02		2.7E+01	2.0E+03	2.1E+04		1.9E+03	
				1.0E-01	I					1	2.36	1	Yes	Carbaryl	63-25-2					1.6E+03	1.7E+04		1.4E+03	
				5.0E-03	I					1	2.32	1	Yes	Carbofuran	1563-66-2					7.8E+01	1.0E+03		7.3E+01	4.0E+01
				1.0E-01	I	7.0E-01	I	V		1	1.94	1	Yes	Carbon Disulfide	75-15-0					1.6E+03	1.3E+04	1.5E+03	7.2E+02	
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		1	2.83	1	Yes	Carbon Tetrachloride	56-23-5	9.6E-01	3.7E+00	8.1E-01	3.9E-01	6.3E+01	2.4E+02	2.1E+02	4.0E+01	5.0E+00
				1.0E-02	I					1	5.57	0.8	Yes	Carbosulfan	55285-14-8					1.6E+02	4.9E+01		3.7E+01	
				1.0E-01	I					1	2.14	1	Yes	Carboxin	5234-68-4					1.6E+03	2.9E+04		1.5E+03	
						9.0E-04	I			1		1	Yes	Ceric oxide	1306-38-3									
				1.0E-01	I					1	0.99	1	Yes	Chloral Hydrate	302-17-0					1.6E+03	1.1E+05		1.5E+03	
				1.5E-02	I					1	1.9	1	Yes	Chloramben	133-90-4					2.3E+02	5.2E+03		2.2E+02	
4.0E-01	H									1	2.22	1	Yes	Chloranil	118-75-2	1.7E-01	3.0E+00		1.6E-01					
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			1	6.22	0.7	No	Chlordane	12789-03-6	1.9E-01			1.9E-01	7.8E+00			7.8E+00	2.0E+00
1.0E+01	I	4.6E-03	C	3.0E-04	I					1	5.41	0.8	Yes	Chlordecone (Kepone)	143-50-0	6.7E-03	5.5E-03		3.0E-03	4.7E+00	3.8E+00		2.1E+00	
				7.0E-04	A					1	3.81	0.9	Yes	Chlorfenvinphos	470-90-6					1.1E+01	4.0E+01		8.6E+00	
				2.0E-02	I					1	2.5	1	Yes	Chlorimuron, Ethyl-	90982-32-4					3.1E+02	1.1E+04		3.0E+02	
				1.0E-01	I	1.5E-04	A			1		1	Yes	Chlorine	7782-50-5					1.6E+03	2.4E+05		1.6E+03	
				3.0E-02	I	2.0E-04	I			1		1	Yes	Chlorine Dioxide	10049-04-4					4.7E+02	7.1E+04		4.7E+02	
				3.0E-02	I					1		1	Yes	Chlorite (Sodium Salt)	7758-19-2					4.7E+02	7.1E+04		4.7E+02	1.0E+03
						5.0E+01	I	V		1	2.05	1	Yes	Chloro-1,1-difluoroethane, 1-	75-68-3							1.0E+05	1.0E+05	
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		1	2.5253	1	Yes	Chloro-1,3-butadiene, 2-	126-99-8			1.6E-02	1.6E-02	3.1E+02	1.2E+03	4.2E+01	3.6E+01	
4.6E-01	H									1	-1.42	1	Yes	Chloro-2-methylaniline HCl, 4-	3165-93-3	1.5E-01	4.3E+02		1.5E-01					
1.0E-01	P	7.7E-05	C	3.0E-03	X					1	2.27	1	Yes	Chloro-2-methylaniline, 4-	95-69-2	6.7E-01	5.6E+00		6.0E-01	4.7E+01	3.9E+02		4.2E+01	
2.7E-01	X							V		1	0.09	1	Yes	Chloroacetaldehyde, 2-	107-20-0	2.5E-01	3.9E+01		2.5E-01					
				2.0E-03	H					1	0.22	1	Yes	Chloroacetic Acid	79-11-8					3.1E+01	4.3E+03		3.1E+01	6.0E+01
						3.0E-05	I			1	1.93	1	Yes	Chloroacetophenone, 2-	532-27-4									
2.0E-01	P			4.0E-03	I					1	1.83	1	Yes	Chloroaniline, p-	106-47-8	3.4E-01	5.0E+00		3.2E-01	6.3E+01	9.4E+02		5.9E+01	

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				2.0E-02	I	5.0E-02	P	V		1	2.84	1	Yes	Chlorobenzene	108-90-7					3.1E+02	9.1E+02	1.0E+02	7.2E+01	1.0E+02
1.1E-01	C	3.1E-05	C	2.0E-02	I					1	4.74	0.8	Yes	Chlorobenzilate	510-15-6	6.1E-01	4.8E-01		2.7E-01	3.1E+02	2.5E+02		1.4E+02	
				3.0E-02	X					1	2.65	1	Yes	Chlorobenzoic Acid, p-	74-11-3					4.7E+02	2.4E+03		3.9E+02	
				3.0E-03	P	3.0E-01	P	V		1	3.6	1	Yes	Chlorobenzotrifluoride, 4-	98-56-6					4.7E+01	6.6E+01	6.3E+02	2.6E+01	
				4.0E-02	P			V		1	2.64	1	Yes	Chlorobutane, 1-	109-69-3					6.3E+02	2.1E+03		4.8E+02	
						5.0E+01	I	V		1	1.08	1	Yes	Chlorodifluoromethane	75-45-6							1.0E+05	1.0E+05	
				2.0E-02	P					1	0.03	1	Yes	Chloroethanol, 2-	107-07-3					3.1E+02	5.1E+04		3.1E+02	
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1	1.97	1	Yes	Chloroform	67-66-3	2.2E+00	2.5E+01	2.1E-01	1.9E-01	1.6E+02	1.8E+03	2.0E+02	8.4E+01	8.0E+01(F)
						9.0E-02	I	V		1	0.91	1	Yes	Chloromethane	74-87-3							1.9E+02	1.9E+02	
2.4E+00	C	6.9E-04	C					V		1	0.32	1	Yes	Chloromethyl Methyl Ether	107-30-2	2.8E-02	3.1E+00	7.1E-03	5.6E-03					
				8.0E-02	I			V		1	3.9	1	Yes	Chloronaphthalene, Beta-	91-58-7					1.3E+03	9.9E+02		5.5E+02	
3.0E-01	P			3.0E-03	P	1.0E-05	X			1	2.24	1	Yes	Chloronitrobenzene, o-	88-73-3	2.2E-01	2.2E+00		2.0E-01	4.7E+01	4.6E+02		4.3E+01	
6.3E-03	P			1.0E-03	P	6.0E-04	P			1	2.39	1	Yes	Chloronitrobenzene, p-	100-00-5	1.1E+01	8.2E+01		9.4E+00	1.6E+01	1.2E+02		1.4E+01	
				5.0E-03	I			V		1	2.15	1	Yes	Chlorophenol, 2-	95-57-8					7.8E+01	7.2E+02		7.1E+01	
						4.0E-04	C	V		1	2.09	1	Yes	Chloropicrin	76-06-2							8.3E-01	8.3E-01	
3.1E-03	C	8.9E-07	C	1.5E-02	I					1	3.05	0.9	Yes	Chlorothalonil	1897-45-6	2.2E+01	1.4E+02		1.9E+01	2.3E+02	1.5E+03		2.0E+02	
				2.0E-02	I			V		1	3.42	1	Yes	Chlorotoluene, o-	95-49-8					3.1E+02	4.1E+02		1.8E+02	
				2.0E-02	X			V		1	3.33	1	Yes	Chlorotoluene, p-	106-43-4					3.1E+02	4.7E+02		1.9E+02	
2.4E+02	C	6.9E-02	C							1	-1.02	1	Yes	Chlorozotocin	54749-90-5	2.8E-04	6.3E-01		2.8E-04					
				2.0E-01	I					1	3.51	0.9	Yes	Chlorpropham	101-21-3					3.1E+03	7.0E+03		2.2E+03	
				1.0E-03	A					1	4.96	0.8	Yes	Chlorpyrifos	2921-88-2					1.6E+01	1.0E+01		6.2E+00	
				1.0E-02	H					1	4.31	0.9	Yes	Chlorpyrifos Methyl	5598-13-0					1.6E+02	2.1E+02		8.9E+01	
				5.0E-02	I					1	2	1	Yes	Chlorsulfuron	64902-72-3					7.8E+02	4.0E+04		7.7E+02	
				8.0E-04	H					1	5.8	0.8	Yes	Chlorthiophos	60238-56-4					1.3E+01	2.4E+00		2.0E+00	
				1.5E+00	I					0.013		1	Yes	Chromium(III), Insoluble Salts	16065-83-1					2.3E+04	4.6E+04		1.6E+04	
5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I		M	0.025		1	Yes	Chromium(VI)	18540-29-9	4.3E-02	1.1E-01		3.1E-02	4.7E+01	8.9E+01		3.1E+01	
										0.013		1	Yes	Chromium, Total	7440-47-3									1.0E+02
		9.0E-03	P	3.0E-04	P	6.0E-06	P			1		1	Yes	Cobalt	7440-48-4					4.7E+00	1.8E+03		4.7E+00	
		6.2E-04	I						M	1				Coke Oven Emissions	8007-45-2									
				4.0E-02	H					1		1	Yes	Copper	7440-50-8					6.3E+02	9.5E+04		6.2E+02	1.3E+03
				5.0E-02	I	6.0E-01	C			1	1.96	1	Yes	Cresol, m-	108-39-4					7.8E+02	8.5E+03		7.2E+02	
				5.0E-02	I	6.0E-01	C			1	1.95	1	Yes	Cresol, o-	95-48-7					7.8E+02	8.6E+03		7.2E+02	
				1.0E-01	A	6.0E-01	C			1	1.94	1	Yes	Cresol, p-	106-44-5					1.6E+03	1.7E+04		1.4E+03	
				1.0E-01	A					1	3.1	1	Yes	Cresol, p-chloro-m-	59-50-7					1.6E+03	3.7E+03		1.1E+03	
				1.0E-01	A	6.0E-01	C			1	1.95	1	Yes	Cresols	1319-77-3					1.6E+03	1.7E+04		1.4E+03	
1.9E+00	H			1.0E-03	P			V		1	0.6	1	Yes	Crotonaldehyde, trans-	123-73-9	3.5E-02	2.3E+00		3.5E-02	1.6E+01	9.8E+02		1.5E+01	
				1.0E-01	I	4.0E-01	I	V		1	3.66	1	Yes	Cumene	98-82-8					1.6E+03	1.4E+03	8.3E+02	3.9E+02	
2.2E-01	C	6.3E-05	C							1	-3.16	1	No	Cupferron	135-20-6	3.1E-01			3.1E-01					
8.4E-01	H			2.0E-03	H					1	2.22	1	Yes	Cyanazine	21725-46-2	8.0E-02	1.4E+00		7.6E-02	3.1E+01	5.4E+02		3.0E+01	
														Cyanides										
				1.0E-03	I					1		1	Yes	~Calcium Cyanide	592-01-8					1.6E+01	2.4E+03		1.6E+01	
				5.0E-03	I					1		1	Yes	~Copper Cyanide	544-92-3					7.8E+01	1.2E+04		7.8E+01	
				6.0E-04	I	8.0E-04	S	V		1	-0.25	1	Yes	~Cyanide (CN-)	57-12-5					9.4E+00	1.4E+03	1.7E+00	1.4E+00	2.0E+02
				1.0E-03	I			V		1	0.07	1	Yes	~Cyanogen	460-19-5					1.6E+01	2.7E+03		1.6E+01	
				9.0E-02	I			V		1		1	Yes	~Cyanogen Bromide	506-68-3					1.4E+03	8.4E+05		1.4E+03	
				5.0E-02	I			V		1		1	Yes	~Cyanogen Chloride	506-77-4					7.8E+02	3.0E+05		7.8E+02	
				6.0E-04	I	8.0E-04	I	V		1	-0.25	1	Yes	~Hydrogen Cyanide	74-90-8					9.4E+00	1.4E+03	1.7E+00	1.4E+00	
				2.0E-03	I					1		1	Yes	~Potassium Cyanide	151-50-8					3.1E+01	2.4E+03		3.1E+01	
				5.0E-03	I					0.04		1	Yes	~Potassium Silver Cyanide	506-61-6					7.8E+01	2.4E+02		5.9E+01	
				1.0E-01	I					0.04		1	Yes	~Silver Cyanide	506-64-9					1.6E+03	9.5E+03		1.3E+03	
				1.0E-03	I					1		1	Yes	~Sodium Cyanide	143-33-9					1.6E+01	2.4E+03		1.6E+01	2.0E+02
				2.0E-04	P					1			Yes	~Thiocyanates	NA					3.1E+00	4.7E+02		3.1E+00	
				2.0E-04	X					1		1	Yes	~Thiocyanic Acid	463-56-9					3.1E+00	4.7E+02		3.1E+00	
				5.0E-02	I					1		1	Yes	~Zinc Cyanide	557-21-1					7.8E+02	2.0E+05		7.8E+02	
						6.0E+00	I	V		1	3.44	1	Yes	Cyclohexane	110-82-7							1.3E+04	1.3E+04	
2.3E-02	H									1	4.72	0.9	Yes	Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.9E+00	7.1E+00		2.1E+00					
				5.0E+00	I	7.0E-01	P			1	0.81	1	Yes	Cyclohexanone	108-94-1					7.8E+04	4.5E+06		7.7E+04	
				5.0E-03	P	1.0E+00	X	V		1	2.86	1	Yes	Cyclohexene	110-83-8					7.8E+01	1.8E+02	2.1E+03	5.3E+01	
				2.0E-01	I					1	1.49	1	Yes	Cyclohexylamine	108-91-8					3.1E+03	6.4E+04		3.0E+03	
				5.0E-03	I					1	6.8	0.5	No	Cyhalothrin/karate	68085-85-8					7.8E+01			7.8E+01	
				1.0E-02	I					1	6.6	0.7	No	Cypermethrin	52315-07-8					1.6E+02			1.6E+02	
				7.5E-03	I					1	0.96	1	Yes	Cyromazine	66215-27-8					1.2E+02	8.5E+03		1.2E+02	
2.4E-01	I	6.9E-05	C							1	6.02	0.8	Yes	DDD	72-54-8	2.8E-01	3.0E-02		2.7E-02					
3.4E-01	I	9.7E-05	C							1	6.51	0.8	No	DDE, p,p'-	72-55-9	2.0E-01			2.0E-01					
3.4E-01	I	9.7E-05	I	5.0E-04	I					1	6.91	0.7	No	DDT	50-29-3	2.0E-01			2.0E-01	7.8E+00			7.8E+00	

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Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				1.0E-02	I					1	4.28	0.9	Yes	Dacthal	1861-32-1					1.6E+02	2.3E+02		9.3E+01	
				3.0E-02	I					1	0.78	1	Yes	Dalapon	75-99-0					4.7E+02	3.9E+04		4.6E+02	2.0E+02
7.0E-04	I			7.0E-03	I					1	12.11	0	No	Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	9.6E+01			9.6E+01	1.1E+02			1.1E+02	
				4.0E-05	I					1	3.2146	0.9	Yes	Demeton	8065-48-3					6.3E-01	2.9E+00		5.2E-01	
1.2E-03	I			6.0E-01	I					1	8.12	0	No	Di(2-ethylhexyl)adipate	103-23-1	5.6E+01			5.6E+01	9.4E+03			9.4E+03	4.0E+02
6.1E-02	H									1	4.49	0.9	Yes	Diallate	2303-16-4	1.1E+00	7.9E-01		4.6E-01					
				7.0E-04	A					1	3.81	0.9	Yes	Diazinon	333-41-5					1.1E+01	2.8E+01		7.9E+00	
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	1	2.96	1	Yes	Dibromo-3-chloropropane, 1,2-	96-12-8	2.7E-02	1.6E-01	3.2E-04	3.2E-04	3.1E+00	1.7E+01	4.2E-01	3.6E-01	2.0E-01
				1.0E-02	I					1	3.79	0.9	Yes	Dibromobenzene, 1,4-	106-37-6					1.6E+02	2.6E+02		9.8E+01	
8.4E-02	I	2.7E-05	C	2.0E-02	I			V		1	2.16	1	Yes	Dibromochloromethane	124-48-1	8.0E-01	1.2E+01	1.8E-01	1.5E-01	3.1E+02	4.8E+03		2.9E+02	8.0E+01(F)
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1	1.96	1	Yes	Dibromoethane, 1,2-	106-93-4	3.4E-02	6.1E-01	8.1E-03	6.5E-03	1.4E+02	2.5E+03	1.9E+01	1.6E+01	5.0E-02
				1.0E-02	H	4.0E-03	X	V		1	1.7	1	Yes	Dibromomethane (Methylene Bromide)	74-95-3					1.6E+02	3.9E+03	8.3E+00	7.9E+00	
				1.0E-01	I					1	4.5	0.9	Yes	Dibutyl Phthalate	84-74-2					1.6E+03	1.2E+03		6.7E+02	
				3.0E-04	P					1			No	Dibutyltin Compounds	NA					4.7E+00			4.7E+00	
				3.0E-02	I					1	2.21	1	Yes	Dicamba	1918-00-9					4.7E+02	7.2E+03		4.4E+02	
		4.2E-03	P					V		1	2.6	1	Yes	Dichloro-2-butene, 1,4-	764-41-0			1.2E-03	1.2E-03					
		4.2E-03	P					V		1	2.6	1	Yes	Dichloro-2-butene, cis-1,4-	1476-11-5			1.2E-03	1.2E-03					
		4.2E-03	P					V		1	2.6	1	Yes	Dichloro-2-butene, trans-1,4-	110-57-6			1.2E-03	1.2E-03					
5.0E-02	I			4.0E-03	I					1	0.92	1	Yes	Dichloroacetic Acid	79-43-6	1.3E+00	8.2E+01		1.3E+00	6.3E+01	3.8E+03		6.2E+01	6.0E+01
				9.0E-02	I	2.0E-01	H	V		1	3.43	1	Yes	Dichlorobenzene, 1,2-	95-50-1					1.4E+03	2.1E+03	4.2E+02	2.8E+02	6.0E+02
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		1	3.44	1	Yes	Dichlorobenzene, 1,4-	106-46-7	1.2E+01	1.8E+01	4.4E-01	4.2E-01	1.1E+03	1.6E+03	1.7E+03	4.7E+02	7.5E+01
4.5E-01	I	3.4E-04	C							1	3.51	1	Yes	Dichlorobenzidine, 3,3'-	91-94-1	1.5E-01	3.9E-01		1.1E-01					
				9.0E-03	X					1	4.44	0.9	Yes	Dichlorobenzophenone, 4,4'-	90-98-2					1.4E+02	9.7E+01		5.7E+01	
				2.0E-01	I	1.0E-01	X	V		1	2.16	1	Yes	Dichlorodifluoromethane	75-71-8					3.1E+03	2.7E+04	2.1E+02	1.9E+02	
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1	1.79	1	Yes	Dichloroethane, 1,1-	75-34-3	1.2E+01	1.6E+02	3.0E+00	2.4E+00	3.1E+03	4.0E+04		2.9E+03	
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		1	1.48	1	Yes	Dichloroethane, 1,2-	107-06-2	7.4E-01	1.6E+01	1.9E-01	1.5E-01	9.4E+01	1.9E+03	1.5E+01	1.3E+01	5.0E+00
				5.0E-02	I	2.0E-01	I	V		1	2.13	1	Yes	Dichloroethylene, 1,1-	75-35-4					7.8E+02	5.9E+03	4.2E+02	2.6E+02	7.0E+00
				9.0E-03	H			V		1	2.09	1	Yes	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0					1.4E+02	1.1E+03		1.3E+02	
				2.0E-03	I			V		1	1.86	1	Yes	Dichloroethylene, 1,2-cis-	156-59-2					3.1E+01	2.5E+02		2.8E+01	7.0E+01
				2.0E-02	I	6.0E-02	P	V		1	2.09	1	Yes	Dichloroethylene, 1,2-trans-	156-60-5					3.1E+02	2.5E+03	1.3E+02	8.6E+01	1.0E+02
				3.0E-03	I					1	3.06	1	Yes	Dichlorophenol, 2,4-	120-83-2					4.7E+01	1.3E+02		3.5E+01	
				1.0E-02	I					1	2.81	1	Yes	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					1.6E+02	9.6E+02		1.3E+02	7.0E+01
				8.0E-03	I					1	3.53	0.9	Yes	Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6					1.3E+02	3.4E+02		9.1E+01	
3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		1	1.98	1	Yes	Dichloropropane, 1,2-	78-87-5	1.9E+00	2.0E+01	4.9E-01	3.8E-01	1.4E+03	1.5E+04	8.3E+00	8.3E+00	5.0E+00
				2.0E-02	P			V		1	2	1	Yes	Dichloropropane, 1,3-	142-28-9					3.1E+02	3.3E+03		2.9E+02	
				3.0E-03	I					1	0.78	1	Yes	Dichloropropanol, 2,3-	616-23-9					4.7E+01	3.5E+03		4.6E+01	
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1	2.04	1	Yes	Dichloropropene, 1,3-	542-75-6	6.7E-01	6.7E+00	1.2E+00	4.1E-01	4.7E+02	4.7E+03	4.2E+01	3.8E+01	
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1	1.43	1	Yes	Dichlorvos	62-73-7	2.3E-01	1.2E+01		2.3E-01	7.8E+00	4.0E+02		7.7E+00	
				8.0E-03	P	7.0E-03	P	V		1	3.51	1	Yes	Dicyclopentadiene	77-73-6					1.3E+02	2.5E+02	1.5E+01	1.2E+01	
1.6E+01	I	4.6E-03	I	5.0E-05	I					1	5.4	0.8	Yes	Dieldrin	60-57-1	4.2E-03	2.3E-03		1.5E-03	7.8E-01	4.3E-01		2.8E-01	
		3.0E-04	C			5.0E-03	I			1				Diesel Engine Exhaust	NA									
				2.0E-03	P	2.0E-04	P			1	-1.43	1	Yes	Diethanolamine	111-42-2					3.1E+01	5.8E+04		3.1E+01	
				8.0E-01	I					1	2.42	1	Yes	Diethyl Phthalate	84-66-2					1.3E+04	1.4E+05		1.1E+04	
				3.0E-02	P	1.0E-04	P			1	0.56	1	Yes	Diethylene Glycol Monobutyl Ether	112-34-5					4.7E+02	6.1E+04		4.7E+02	
				6.0E-02	P	3.0E-04	P			1	-0.54	1	Yes	Diethylene Glycol Monoethyl Ether	111-90-0					9.4E+02	5.5E+05		9.4E+02	
				1.0E-03	P					1	0.05	1	Yes	Diethylformamide	617-84-5					1.6E+01	2.9E+03		1.6E+01	
3.5E+02	C	1.0E-01	C							1	5.07	0.9	Yes	Diethylstilbestrol	56-53-1	1.9E-04	5.6E-05		4.3E-05					
				8.0E-02	I					1	0.65	1	Yes	Difenzoquat	43222-48-6					1.3E+03	5.2E+05		1.2E+03	
				2.0E-02	I					1	3.88	0.9	Yes	Diflubenzuron	35367-38-5					3.1E+02	7.4E+02		2.2E+02	
						4.0E+01	I	V		1	0.75	1	Yes	Difluoroethane, 1,1-	75-37-6							8.3E+04	8.3E+04	
4.4E-02	C	1.3E-05	C					V		1	3.58	1	Yes	Dihydrosafrole	94-58-6	1.5E+00	2.0E+00	3.7E-01	2.6E-01					
						7.0E-01	P	V		1	1.52	1	Yes	Diisopropyl Ether	108-20-3							1.5E+03	1.5E+03	
				8.0E-02	I			V		1	1.03	1	Yes	Diisopropyl Methylphosphonate	1445-75-6					1.3E+03	9.0E+04		1.2E+03	
				2.0E-02	I					1	-0.17	1	Yes	Dimethipin	55290-64-7					3.1E+02	1.7E+05		3.1E+02	
				2.0E-04	I					1	0.78	1	Yes	Dimethoate	60-51-5					3.1E+00	4.5E+02		3.1E+00	
1.4E-02	H									1	1.81	1	Yes	Dimethoxybenzidine, 3,3'-	119-90-4	4.8E+00	1.6E+02		4.7E+00					
1.7E-03	P			6.0E-02	P					1	-0.61	1	Yes	Dimethyl methylphosphonate	756-79-6	4.0E+01	2.4E+04		3.9E+01	9.4E+02	5.7E+05		9.4E+02	
4.6E+00	C	1.3E-03	C							1	4.58	1	Yes	Dimethylamino azobenzene [p-]	60-11-7	1.5E-02	6.1E-03		4.3E-03					
5.8E-01	H									1	-1.51	1	Yes	Dimethylaniline HCl, 2,4-	21436-96-4	1.2E-01	3.5E+02		1.2E-01					
2.0E-01	P			2.0E-03	X					1	1.68	1	Yes	Dimethylaniline, 2,4-	95-68-1	3.4E-01	6.1E+00		3.2E-01	3.1E+01	5.7E+02		3.0E+01	
				2.0E-03	I			V		1	2.31	1	Yes	Dimethylaniline, N,N-	121-69-7					3.1E+01	2.2E+02		2.7E+01	
1.1E+01	P									1	2.34	1	Yes	Dimethylbenzidine, 3,3'-	119-93-7	6.1E-03	7.2E-02		5.6E-03					
				1.0E-01	P	3.0E-02	I			1	-1.01	1	Yes	Dimethylformamide	68-12-2					1.6E+03	1.2E+06		1.6E+03	
				1.0E-04	X	2.0E-06	X			1	-1.19	1	Yes	Dimethylhydrazine, 1,1-	57-14-7					1.6E+00	2.2E+03		1.6E+00	
5.5E+02	C	1.6E-01	C							1	-0.54	1	Yes	Dimethylhydrazine, 1,2-	540-73-8	1.2E-04	4.2E-02		1.2E-04					

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				2.0E-02	I					1	2.3	1	Yes	Dimethylphenol, 2,4-	105-67-9					3.1E+02	2.2E+03		2.7E+02	
				6.0E-04	I					1	2.36	1	Yes	Dimethylphenol, 2,6-	576-26-1					9.4E+00	6.0E+01		8.1E+00	
				1.0E-03	I					1	2.23	1	Yes	Dimethylphenol, 3,4-	95-65-8					1.6E+01	1.2E+02		1.4E+01	
				1.0E-01	I			V		1	2.25	1	Yes	Dimethylterephthalate	120-61-6					1.6E+03	1.9E+04		1.4E+03	
4.5E-02	C	1.3E-05	C					V		1	2.58	1	Yes	Dimethylvinylchloride	513-37-1	1.5E+00	5.6E+00	3.7E-01	2.8E-01					
				8.0E-05	X					1	2.13	1	Yes	Dinitro-o-cresol, 4,6-	534-52-1					1.3E+00	1.9E+01		1.2E+00	
				2.0E-03	I					1	4.12	0.9	Yes	Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					3.1E+01	3.8E+01		1.7E+01	
				1.0E-04	P					1	1.69	1	Yes	Dinitrobenzene, 1,2-	528-29-0					1.6E+00	3.8E+01		1.5E+00	
				1.0E-04	I					1	1.49	1	Yes	Dinitrobenzene, 1,3-	99-65-0					1.6E+00	5.1E+01		1.5E+00	
				1.0E-04	P					1	1.46	1	Yes	Dinitrobenzene, 1,4-	100-25-4					1.6E+00	5.4E+01		1.5E+00	
				2.0E-03	I					1	1.67	1	Yes	Dinitrophenol, 2,4-	51-28-5					3.1E+01	8.6E+02		3.0E+01	
6.8E-01	I									1	2.18	1	Yes	Dinitrotoluene Mixture, 2,4/2,6-	NA	9.9E-02	1.2E+00		9.2E-02					
3.1E-01	C	8.9E-05	C	2.0E-03	I					1	1.98	1	Yes	Dinitrotoluene, 2,4-	121-14-2	2.2E-01	3.7E+00		2.0E-01	3.1E+01	5.3E+02		3.0E+01	
1.5E+00	P			3.0E-04	X					1	2.1	1	Yes	Dinitrotoluene, 2,6-	606-20-2	4.5E-02	6.3E-01		4.2E-02	4.7E+00	6.6E+01		4.4E+00	
				2.0E-03	S					1	1.84	1	Yes	Dinitrotoluene, 2-Amino-4,6-	35572-78-2					3.1E+01	7.3E+02		3.0E+01	
				2.0E-03	S					1	1.84	1	Yes	Dinitrotoluene, 4-Amino-2,6-	19406-51-0					3.1E+01	7.3E+02		3.0E+01	
4.5E-01	X			9.0E-04	X					1	2.18	1	Yes	Dinitrotoluene, Technical grade	25321-14-6	1.5E-01	1.9E+00		1.4E-01	1.4E+01	1.8E+02		1.3E+01	
				1.0E-03	I					1	3.56	0.9	Yes	Dinoseb	88-85-7					1.6E+01	3.8E+01		1.1E+01	7.0E+00
1.0E-01	I	7.7E-06	C	3.0E-02	I	1.1E-01	A			1	-0.27	1	Yes	Dioxane, 1,4-	123-91-1	6.7E-01	1.9E+02		6.7E-01	4.7E+02	1.3E+05		4.7E+02	
														Dioxins										
6.2E+03	I	1.3E+00	I							1	8.21	0	No	~Hexachlorodibenzo-p-dioxin, Mixture	NA	1.1E-05			1.1E-05					
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C			1	6.8	0.5	No	~TCDD, 2,3,7,8-	1746-01-6	5.2E-07			5.2E-07	1.1E-05			1.1E-05	3.0E-05
				3.0E-02	I					1	2.86	1	Yes	Diphenamid	957-51-7					4.7E+02	3.0E+03		4.1E+02	
				8.0E-04	X					1	2.4	1	Yes	Diphenyl Sulfone	127-63-9					1.3E+01	1.4E+02		1.1E+01	
				2.5E-02	I					1	3.5	1	Yes	Diphenylamine	122-39-4					3.9E+02	6.0E+02		2.4E+02	
8.0E-01	I	2.2E-04	I							1	2.94	1	Yes	Diphenylhydrazine, 1,2-	122-66-7	8.4E-02	3.3E-01		6.7E-02					
				2.2E-03	I					1	-2.82	1	No	Diquat	85-00-7					3.4E+01			3.4E+01	2.0E+01
7.4E+00	C	2.1E-03	C							1	4.9	1	No	Direct Black 38	1937-37-7	9.1E-03			9.1E-03					
7.4E+00	C	2.1E-03	C							1	-2.03	1	No	Direct Blue 6	2602-46-2	9.1E-03			9.1E-03					
6.7E+00	C	1.9E-03	C							1	-6.53	1	No	Direct Brown 95	16071-86-6	1.0E-02			1.0E-02					
				4.0E-05	I					1	4.02	0.9	Yes	Disulfoton	298-04-4					6.3E-01	9.5E-01		3.8E-01	
				1.0E-02	I			V		1	0.77	1	Yes	Dithiane, 1,4-	505-29-3					1.6E+02	1.1E+04		1.5E+02	
				2.0E-03	I					1	2.68	1	Yes	Diuron	330-54-1					3.1E+01	2.5E+02		2.8E+01	
				4.0E-03	I					1	1.15	1	Yes	Dodine	2439-10-3					6.3E+01	7.5E+03		6.2E+01	
				2.5E-02	I			V		1	3.21	1	Yes	EPTC	759-94-4					3.9E+02	1.1E+03		2.9E+02	
				6.0E-03	I					1	3.83	0.9	Yes	Endosulfan	115-29-7					9.4E+01	4.5E+02		7.8E+01	
				2.0E-02	I					1	1.91	1	Yes	Endothall	145-73-3					3.1E+02	6.1E+03		3.0E+02	1.0E+02
				3.0E-04	I					1	5.2	0.8	Yes	Endrin	72-20-8					4.7E+00	2.6E+00		1.7E+00	2.0E+00
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1	0.45	1	Yes	Epichlorohydrin	106-89-8	6.8E+00	6.7E+02	4.1E+00	2.5E+00	9.4E+01	8.9E+03	2.1E+00	2.0E+00	
						2.0E-02	I	V		1	0.86	1	Yes	Epoxybutane, 1,2-	106-88-7							4.2E+01	4.2E+01	
				5.0E-03	I					1	-0.22	1	Yes	Ethephon	16672-87-0					7.8E+01	3.0E+04		7.8E+01	
				5.0E-04	I					1	5.07	0.8	Yes	Ethion	563-12-2					7.8E+00	5.4E+00		3.2E+00	
				1.0E-01	P	6.0E-02	P			1	0.59	1	Yes	Ethoxyethanol Acetate, 2-	111-15-9					1.6E+03	1.6E+05		1.5E+03	
				4.0E-01	H	2.0E-01	I			1	-0.32	1	Yes	Ethoxyethanol, 2-	110-80-5					6.3E+03	1.9E+06		6.2E+03	
				9.0E-01	I			V		1	0.73	1	Yes	Ethyl Acetate	141-78-6					1.4E+04	8.4E+05		1.4E+04	
4.8E-02	H							V		1	1.32	1	Yes	Ethyl Acrylate	140-88-5	1.4E+00	3.8E+01		1.4E+00					
						1.0E+01	I	V		1	1.43	1	Yes	Ethyl Chloride	75-00-3							2.1E+04	2.1E+04	
				2.0E-01	I			V		1	0.89	1	Yes	Ethyl Ether	60-29-7					3.1E+03	1.3E+05		3.1E+03	
				9.0E-02	H	3.0E-01	P	V		1	1.94	1	Yes	Ethyl Methacrylate	97-63-2					1.4E+03	1.6E+04	6.3E+02	4.2E+02	
				1.0E-05	I					1	4.78	0.8	Yes	Ethyl-p-nitrophenyl Phosphonate	2104-64-5					1.6E-01	1.1E-01		6.6E-02	
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		1	3.15	1	Yes	Ethylbenzene	100-41-4	6.1E+00	1.1E+01	1.9E+00	1.3E+00	1.6E+03	2.6E+03	2.1E+03	6.7E+02	7.0E+02
				7.0E-02	P					1	-0.94	1	Yes	Ethylene Cyanohydrin	109-78-4					1.1E+03	7.3E+05		1.1E+03	
				9.0E-02	P					1	-2.04	1	No	Ethylene Diamine	107-15-3					1.4E+03			1.4E+03	
				2.0E+00	I	4.0E-01	C			1	-1.36	1	Yes	Ethylene Glycol	107-21-1					3.1E+04	3.7E+07		3.1E+04	
				1.0E-01	I	1.6E+00	I			1	0.83	1	Yes	Ethylene Glycol Monobutyl Ether	111-76-2					1.6E+03	1.0E+05		1.5E+03	
3.1E-01	C	8.8E-05	C			3.0E-02	C	V		1	-0.3	1	Yes	Ethylene Oxide	75-21-8	2.2E-01	4.6E+01	5.5E-02	4.4E-02			6.3E+01	6.3E+01	
4.5E-02	C	1.3E-05	C	8.0E-05	I					1	-0.66	1	Yes	Ethylene Thiourea	96-45-7	1.5E+00	8.6E+02		1.5E+00	1.3E+00	7.0E+02		1.2E+00	
6.5E+01	C	1.9E-02	C					V		1	-0.28	1	Yes	Ethyleneimine	151-56-4	1.0E-03	2.1E-01	2.6E-04	2.1E-04					
				3.0E+00	I					1	2.19	1	Yes	Ethylphthalyl Ethyl Glycolate	84-72-0					4.7E+04	1.1E+06		4.5E+04	
				8.0E-03	I					1	2.55	1	Yes	Express	101200-48-0					1.3E+02	3.5E+03		1.2E+02	
				2.5E-04	I					1	3.23	0.9	Yes	Fenamiphos	22224-92-6					3.9E+00	2.4E+01		3.4E+00	
				2.5E-02	I					1	5.7	0.8	Yes	Fenpropathrin	39515-41-8					3.9E+02	5.2E+01		4.6E+01	
				1.3E-02	I					1	2.42	1	Yes	Fluometuron	2164-17-2					2.0E+02	2.4E+03		1.9E+02	
				4.0E-02	C	1.3E-02	C			1		1	Yes	Fluoride	16984-48-8					6.3E+02	9.5E+04		6.2E+02	
				6.0E-02	I	1.3E-02	C			1		1	Yes	Fluorine (Soluble Fluoride)	7782-41-4					9.4E+02	1.4E+05		9.3E+02	4.0E+03

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				8.0E-02	I					1	3.16	0.9	Yes	Fluridone	59756-60-4					1.3E+03	1.0E+04		1.1E+03	
				2.0E-02	I					1	3.34	0.9	Yes	Flurprimidol	56425-91-3					3.1E+02	1.7E+03		2.6E+02	
				6.0E-02	I					1	3.7	0.9	Yes	Flutolanil	66332-96-5					9.4E+02	3.2E+03		7.2E+02	
				1.0E-02	I					1	6.81	0.6	No	Fluvalinate	69409-94-5					1.6E+02			1.6E+02	
3.5E-03	I			1.0E-01	I					1	2.85	1	Yes	Folpet	133-07-3	1.9E+01	1.8E+02		1.7E+01	1.6E+03	1.5E+04		1.4E+03	
1.9E-01	I									1	2.9	1	Yes	Fomesafen	72178-02-0	3.5E-01	7.7E+00		3.4E-01					
				2.0E-03	I					1	3.94	0.9	Yes	Fonofos	944-22-9					3.1E+01	4.4E+01		1.8E+01	
		1.3E-05	I	2.0E-01	I	9.8E-03	A			1	0.35	1	Yes	Formaldehyde	50-00-0					3.1E+03	2.0E+05		3.1E+03	
				9.0E-01	P	3.0E-04	X			1	-0.54	1	Yes	Formic Acid	64-18-6					1.4E+04	4.1E+06		1.4E+04	
				3.0E+00	I					1	-2.4	1	No	Fosetyl-AL	39148-24-8					4.7E+04			4.7E+04	
														Furans										
				1.0E-03	X			V		1	4.12	1	Yes	~Dibenzofuran	132-64-9					1.6E+01	9.2E+00		5.8E+00	
				1.0E-03	I			V		1	1.34	1	Yes	~Furan	110-00-9					1.6E+01	3.1E+02		1.5E+01	
				9.0E-01	I	2.0E+00	I	V		1	0.46	1	Yes	~Tetrahydrofuran	109-99-9					1.4E+04	1.1E+06	4.2E+03	3.2E+03	
3.8E+00	H									1	-0.04	1	Yes	Furazolidone	67-45-8	1.8E-02	8.7E+00		1.8E-02					
				3.0E-03	I	5.0E-02	H			1	0.41	1	Yes	Furfural	98-01-1					4.7E+01	4.9E+03		4.6E+01	
1.5E+00	C	4.3E-04	C							1	1.8	1	Yes	Furium	531-82-8	4.5E-02	1.6E+00		4.4E-02					
3.0E-02	I	8.6E-06	C							1	4.38	0.9	Yes	Furmecyclox	60568-05-0	2.2E+00	1.7E+00		9.6E-01					
				4.0E-04	I					1	-5.34	1	No	Glufosinate, Ammonium	77182-82-2					6.3E+00			6.3E+00	
						8.0E-05	C			1	-0.18	1	Yes	Glutaraldehyde	111-30-8									
				4.0E-04	I	1.0E-03	H			1	-0.12	1	Yes	Glycidyl	765-34-4					6.3E+00	1.2E+03		6.2E+00	
				1.0E-01	I					1	-3.4	1	No	Glyphosate	1071-83-6					1.6E+03			1.6E+03	7.0E+02
				3.0E-03	I					1	4.73	0.8	Yes	Goal	42874-03-3					4.7E+01	4.7E+01		2.4E+01	
				3.0E-03	A	1.0E-02	A			1	2.75	1	Yes	Guthion	86-50-0					4.7E+01	5.9E+02		4.3E+01	
				5.0E-05	I					1	4.07	0.9	Yes	Haloxyfop, Methyl	69806-40-2					7.8E-01	2.2E+00		5.8E-01	
				1.3E-02	I					1	1.56	1	Yes	Harmony	79277-27-3					2.0E+02	2.5E+04		2.0E+02	
4.5E+00	I	1.3E-03	I	5.0E-04	I					1	6.1	0.8	Yes	Heptachlor	76-44-8	1.5E-02	2.0E-03		1.8E-03	7.8E+00	1.0E+00		9.2E-01	4.0E-01
9.1E+00	I	2.6E-03	I	1.3E-05	I					1	4.98	0.8	Yes	Heptachlor Epoxide	1024-57-3	7.4E-03	6.1E-03		3.3E-03	2.0E-01	1.7E-01		9.2E-02	2.0E-01
				2.0E-03	I					1	6.07	0.7	No	Hexabromobenzene	87-82-1					3.1E+01			3.1E+01	
				2.0E-04	I					1			No	Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					3.1E+00			3.1E+00	
1.6E+00	I	4.6E-04	I	8.0E-04	I					1	5.73	0.9	No	Hexachlorobenzene	118-74-1	4.2E-02			4.2E-02	1.3E+01			1.3E+01	1.0E+00
7.8E-02	I	2.2E-05	I	1.0E-03	P					1	4.78	0.9	Yes	Hexachlorobutadiene	87-68-3	8.6E-01	3.7E-01		2.6E-01	1.6E+01	6.8E+00		4.7E+00	
6.3E+00	I	1.8E-03	I	8.0E-03	A					1	3.8	0.9	Yes	Hexachlorocyclohexane, Alpha-	319-84-6	1.1E-02	1.5E-02		6.2E-03	1.3E+02	1.7E+02		7.3E+01	
1.8E+00	I	5.3E-04	I							1	3.78	0.9	Yes	Hexachlorocyclohexane, Beta-	319-85-7	3.7E-02	5.2E-02		2.2E-02					
1.1E+00	C	3.1E-04	C	3.0E-04	I					1	3.72	0.9	Yes	Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	6.1E-02	8.5E-02		3.6E-02	4.7E+00	6.6E+00		2.7E+00	2.0E-01
1.8E+00	I	5.1E-04	I							1	4.14	0.9	Yes	Hexachlorocyclohexane, Technical	608-73-1	3.7E-02	5.2E-02		2.2E-02					
				6.0E-03	I	2.0E-04	I			1	5.04	0.9	Yes	Hexachlorocyclopentadiene	77-47-4					9.4E+01	2.9E+01		2.2E+01	5.0E+01
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I			1	4.14	1	Yes	Hexachloroethane	67-72-1	1.7E+00	1.5E+00		7.9E-01	1.1E+01	9.7E+00		5.1E+00	
				3.0E-04	I					1	7.54	0	No	Hexachlorophene	70-30-4					4.7E+00			4.7E+00	
1.1E-01	I			3.0E-03	I					1	0.87	1	Yes	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	6.1E-01	7.3E+01		6.1E-01	4.7E+01	5.6E+03		4.7E+01	
						1.0E-05	I	V		1	3.2	1	Yes	Hexamethylene Diisocyanate, 1,6-	822-06-0							2.1E-02	2.1E-02	
				4.0E-04	P					1	0.28	1	Yes	Hexamethylphosphoramide	680-31-9					6.3E+00	1.4E+03		6.2E+00	
				6.0E-02	H	7.0E-01	I	V		1	3.9	1	Yes	Hexane, N-	110-54-3					9.4E+02	4.5E+02	1.5E+03	2.5E+02	
				2.0E+00	P					1	0.08	1	Yes	Hexanedioic Acid	124-04-9					3.1E+04	7.7E+06		3.1E+04	
				5.0E-03	I	3.0E-02	I	V		1	1.38	1	Yes	Hexanone, 2-	591-78-6					7.8E+01	1.9E+03	6.3E+01	3.4E+01	
				3.3E-02	I					1	1.85	1	Yes	Hexazinone	51235-04-2					5.2E+02	1.7E+04		5.0E+02	
3.0E+00	I	4.9E-03	I			3.0E-05	P			1	-2.07	1	Yes	Hydrazine	302-01-2	2.2E-02	9.5E+01		2.2E-02					
3.0E+00	I	4.9E-03	I							1		1	Yes	Hydrazine Sulfate	10034-93-2	2.2E-02	4.2E+00		2.2E-02					
						2.0E-02	I			1		1	Yes	Hydrogen Chloride	7647-01-0									
				4.0E-02	C	1.4E-02	C			1		1	Yes	Hydrogen Fluoride	7664-39-3					6.3E+02	9.5E+04		6.2E+02	
						2.0E-03	I			1		1	Yes	Hydrogen Sulfide	7783-06-4									
6.0E-02	P			4.0E-02	P					1	0.59	1	Yes	Hydroquinone	123-31-9	1.1E+00	1.0E+02		1.1E+00	6.3E+02	5.6E+04		6.2E+02	
				1.3E-02	I					1	3.82	0.9	Yes	Imazalil	35554-44-0					2.0E+02	4.8E+02		1.4E+02	
				2.5E-01	I					1	1.86	1	Yes	Imazaquin	81335-37-7					3.9E+03	1.8E+05		3.8E+03	
				1.0E-02	A					1		1	Yes	Iodine	7553-56-2					1.6E+02	2.4E+04		1.6E+02	
				4.0E-02	I					1	3	0.9	Yes	Iprodione	36734-19-7					6.3E+02	6.4E+03		5.7E+02	
				7.0E-01	P					1		1	Yes	Iron	7439-89-6					1.1E+04	1.7E+06		1.1E+04	
				3.0E-01	I					1	0.76	1	Yes	Isobutyl Alcohol	78-83-1					4.7E+03	2.4E+05		4.6E+03	
9.5E-04	I			2.0E-01	I	2.0E+00	C			1	1.7	1	Yes	Isophorone	78-59-1	7.1E+01	1.4E+03		6.7E+01	3.1E+03	6.1E+04		3.0E+03	
				1.5E-02	I					1	5.8	0.8	Yes	Isopropalin	33820-53-0					2.3E+02	3.3E+01		2.9E+01	
						7.0E+00	C			1	0.05	1	Yes	Isopropanol	67-63-0									
				1.0E-01	I					1	0.27	1	Yes	Isopropyl Methyl Phosphonic Acid	1832-54-8					1.6E+03	2.7E+05		1.6E+03	
				5.0E-02	I					1	3.94	0.9	Yes	Isoxaben	82558-50-7					7.8E+02	1.9E+03		5.6E+02	
						3.0E-01	A	V		1			No	JP-7	NA							6.3E+02	6.3E+02	
				7.5E-02	I					1	3.43	0.9	Yes	Kerb	23950-58-5					1.2E+03	3.9E+03		9.0E+02	

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				2.0E-03	I					1	4.81	0.9	Yes	Lactofen	77501-63-4					3.1E+01	4.7E+01		1.9E+01	
														Lead Compounds										
2.8E-01	C	8.0E-05	C							1	-0.08	1	Yes	~Lead acetate	301-04-2	2.4E-01	2.4E+02		2.4E-01					
										1		1	Yes	~Lead and Compounds	7439-92-1									1.5E+01
3.8E-02	C	1.1E-05	C							1	-4	1	No	~Lead subacetate	1335-32-6	1.8E+00			1.8E+00					
				1.0E-07	I					1	4.15	0.9	Yes	~Tetraethyl Lead	78-00-2					1.6E-03	2.7E-03		9.9E-04	
				2.0E-03	I					1	3.2	0.9	Yes	Linuron	330-55-2					3.1E+01	1.4E+02		2.6E+01	
				2.0E-03	P					1		1	Yes	Lithium	7439-93-2					3.1E+01	4.7E+03		3.1E+01	
				2.0E-01	I					1	2.18	1	Yes	Londax	83055-99-6					3.1E+03	1.7E+05		3.1E+03	
				5.0E-04	I					1	3.25	1	Yes	MCPA	94-74-6					7.8E+00	2.1E+01		5.7E+00	
				1.0E-02	I					1	3.5	0.9	Yes	MCPB	94-81-5					1.6E+02	3.9E+02		1.1E+02	
				1.0E-03	I					1	3.13	1	Yes	MCPP	93-65-2					1.6E+01	5.1E+01		1.2E+01	
				2.0E-02	I					1	2.36	1	Yes	Malathion	121-75-5					3.1E+02	7.7E+03		3.0E+02	
				1.0E-01	I	7.0E-04	C			1	1.62	1	Yes	Maleic Anhydride	108-31-6					1.6E+03	2.6E+04		1.5E+03	
				5.0E-01	I					1	-0.84	1	Yes	Maleic Hydrazide	123-33-1					7.8E+03	6.3E+06		7.8E+03	
				1.0E-04	P					1	-0.6	1	Yes	Malononitrile	109-77-3					1.6E+00	6.0E+02		1.6E+00	
				3.0E-02	H					1	1.33	1	Yes	Mancozeb	8018-01-7					4.7E+02	2.6E+04		4.6E+02	
				5.0E-03	I					1	1.33	1	Yes	Maneb	12427-38-2					7.8E+01	4.4E+03		7.7E+01	
				1.4E-01	I	5.0E-05	I			1				Manganese (Diet)	7439-96-5									
				2.4E-02	S	5.0E-05	I			0.04		1	Yes	Manganese (Non-diet)	7439-96-5					3.8E+02	2.3E+03		3.2E+02	
				9.0E-05	H					1	1.04	1	Yes	Mephosfolan	950-10-7					1.4E+00	1.8E+02		1.4E+00	
				3.0E-02	I					1	-2.82	1	No	Mepiquat Chloride	24307-26-4					4.7E+02			4.7E+02	
														Mercury Compounds										
				3.0E-04	I	3.0E-04	S			0.07	-0.22	1	Yes	~Mercuric Chloride (and other Mercury salts)	7487-94-7					4.7E+00	5.0E+01		4.3E+00	2.0E+00
						3.0E-04	I	V		1	0.62	1	Yes	~Mercury (elemental)	7439-97-6							6.3E-01	6.3E-01	2.0E+00
				1.0E-04	I					1		1	Yes	~Methyl Mercury	22967-92-6					1.6E+00	2.4E+02		1.6E+00	
				8.0E-05	I					1	0.71	1	Yes	~Phenylmercuric Acetate	62-38-4					1.3E+00	4.0E+02		1.2E+00	
				3.0E-05	I					1	7.67	0.3	No	Merphos	150-50-5					4.7E-01			4.7E-01	
				3.0E-05	I					1	5.7	0.9	Yes	Merphos Oxide	78-48-8					4.7E-01	7.0E-02		6.1E-02	
				6.0E-02	I					1	1.65	1	Yes	Metalaxyl	57837-19-1					9.4E+02	4.5E+04		9.2E+02	
				1.0E-04	I	3.0E-02	P	V		1	0.68	1	Yes	Methacrylonitrile	126-98-7					1.6E+00	8.5E+01	6.3E+01	1.5E+00	
				5.0E-05	I					1	-0.8	1	Yes	Methamidophos	10265-92-6					7.8E-01	7.2E+02		7.8E-01	
				5.0E-01	I	4.0E+00	C			1	-0.77	1	Yes	Methanol	67-56-1					7.8E+03	2.8E+06		7.8E+03	
				1.0E-03	I					1	2.2	1	Yes	Methidathion	950-37-8					1.6E+01	4.1E+02		1.5E+01	
				2.5E-02	I					1	0.6	1	Yes	Methomyl	16752-77-5					3.9E+02	4.8E+04		3.9E+02	
4.9E-02	C	1.4E-05	C							1	1.47	1	Yes	Methoxy-5-nitroaniline, 2-	99-59-2	1.4E+00	4.6E+01		1.3E+00					
				5.0E-03	I					1	5.08	0.8	Yes	Methoxychlor	72-43-5					7.8E+01	4.2E+01		2.7E+01	4.0E+01
				8.0E-03	P	1.0E-03	P			1	0.1	1	Yes	Methoxyethanol Acetate, 2-	110-49-6					1.3E+02	2.5E+04		1.2E+02	
				5.0E-03	P	2.0E-02	I			1	-0.77	1	Yes	Methoxyethanol, 2-	109-86-4					7.8E+01	4.2E+04		7.8E+01	
				1.0E+00	X			V		1	0.18	1	Yes	Methyl Acetate	79-20-9					1.6E+04	1.9E+06		1.6E+04	
				3.0E-02	H	2.0E-02	P	V		1	0.8	1	Yes	Methyl Acrylate	96-33-3					4.7E+02	2.5E+04	4.2E+01	3.8E+01	
				6.0E-01	I	5.0E+00	I	V		1	0.29	1	Yes	Methyl Ethyl Ketone (2-Butanone)	78-93-3					9.4E+03	9.7E+05	1.0E+04	4.9E+03	
		1.0E-03	X	1.0E-03	P	2.0E-05	X			1	-1.05	1	Yes	Methyl Hydrazine	60-34-4					1.6E+01	9.9E+03		1.6E+01	
				8.0E-02	H	3.0E+00	I	V		1	1.31	1	Yes	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1					1.3E+03	3.4E+04	6.3E+03	1.0E+03	
						1.0E-03	C	V		1	0.79	1	Yes	Methyl Isocyanate	624-83-9							2.1E+00	2.1E+00	
				1.4E+00	I	7.0E-01	I	V		1	1.38	1	Yes	Methyl Methacrylate	80-62-6					2.2E+04	5.3E+05	1.5E+03	1.4E+03	
				2.5E-04	I					1	2.86	1	Yes	Methyl Parathion	298-00-0					3.9E+00	2.9E+01		3.4E+00	
				6.0E-02	X					1	-1	1	Yes	Methyl Phosphonic Acid	993-13-5					9.4E+02	8.4E+05		9.4E+02	
				6.0E-03	H	4.0E-02	H	V		1	3.44	1	Yes	Methyl Styrene (Mixed Isomers)	25013-15-4					9.4E+01	1.1E+02	8.3E+01	3.2E+01	
9.9E-02	C	2.8E-05	C							1	-0.66	1	Yes	Methyl methanesulfonate	66-27-3	6.8E-01	4.1E+02		6.8E-01					
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		1	0.94	1	Yes	Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.7E+01	1.7E+03	1.9E+01	1.2E+01			6.3E+03	6.3E+03	
				3.0E-04	X					1	-2.06	1	Yes	Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					4.7E+00	4.2E+04		4.7E+00	
9.0E-03	P			2.0E-02	X					1	1.87	1	Yes	Methyl-5-Nitroaniline, 2-	99-55-8	7.5E+00	1.2E+02		7.0E+00	3.1E+02	5.2E+03		2.9E+02	
8.3E+00	C	2.4E-03	C							1	-0.92	1	Yes	Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	8.1E-03	9.3E+00		8.1E-03					
1.3E-01	C	3.7E-05	C							1	1.32	1	Yes	Methylaniline Hydrochloride, 2-	636-21-5	5.2E-01	1.2E+01		5.0E-01					
				1.0E-02	A					1	-1.185	1	Yes	Methylarsonic acid	124-58-3					1.6E+02	2.6E+05		1.6E+02	
				2.0E-04	X					1			No	Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					3.1E+00			3.1E+00	
1.0E-01	X			3.0E-04	X					1			No	Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	6.7E-01			6.7E-01	4.7E+00			4.7E+00	
2.2E+01	C	6.3E-03	C						M	1	6.42	0.8	No	Methylcholanthrene, 3-	56-49-5	9.8E-04			9.8E-04					
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	1	1.25	1	Yes	Methylene Chloride	75-09-2	1.1E+01	3.2E+02	1.9E+02	9.9E+00	9.4E+01	2.5E+03	1.3E+03	8.4E+01	5.0E+00
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	1	3.91	0.9	Yes	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.2E-01	4.0E-01		1.4E-01	3.1E+01	5.3E+01		2.0E+01	
4.6E-02	I	1.3E-05	C							1	4.37	1	Yes	Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.5E+00	5.7E-01		4.1E-01					
1.6E+00	C	4.6E-04	C			2.0E-02	C			1	1.59	1	Yes	Methylenebisbenzenamine, 4,4'-	101-77-9	4.2E-02	1.4E+00		4.1E-02					
						6.0E-04	I			1	5.22	0.9	Yes	Methylenediphenyl Diisocyanate	101-68-8									
				7.0E-02	H			V		1	3.48	1	Yes	Methylstyrene, Alpha-	98-83-9					1.1E+03	1.2E+03		5.8E+02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				1.5E-01	I					1	3.13	1	Yes	Metolachlor	51218-45-2					2.3E+03	1.9E+04		2.1E+03	
				2.5E-02	I					1	1.7	1	Yes	Metribuzin	21087-64-9					3.9E+02	1.3E+04		3.8E+02	
				3.0E+00	P			V		1	6.1	1	No	Mineral oils	8012-95-1					4.7E+04			4.7E+04	
1.8E+01	C	5.1E-03	C	2.0E-04	I					1	6.89	0.5	No	Mirex	2385-85-5	3.7E-03			3.7E-03	3.1E+00			3.1E+00	
				2.0E-03	I					1	3.21	1	Yes	Molinate	2212-67-1					3.1E+01	8.4E+01		2.3E+01	
				5.0E-03	I					1		1	Yes	Molybdenum	7439-98-7					7.8E+01	1.2E+04		7.8E+01	
				1.0E-01	I					1		1	Yes	Monochloramine	10599-90-3					1.6E+03	2.4E+05		1.6E+03	4.0E+03
				2.0E-03	P					1	1.66	1	Yes	Monomethylaniline	100-61-8					3.1E+01	5.3E+02		3.0E+01	
				3.0E-04	X					1	4.04	0.9	Yes	N,N'-Diphenyl-1,4-benzenediamine	74-31-7					4.7E+00	6.3E+00		2.7E+00	
				2.0E-03	I					1	1.38	1	Yes	Naled	300-76-5					3.1E+01	4.8E+03		3.1E+01	
				3.0E-02	X	1.0E-01	P	V		1			No	Naphtha, High Flash Aromatic (HFAN)	64724-95-6					4.7E+02		2.1E+02	1.4E+02	
1.8E+00	C	0.0E+00	C							1	2.28	1	Yes	Naphthylamine, 2-	91-59-8	3.7E-02	3.1E-01		3.3E-02					
				1.0E-01	I					1	3.36	0.9	Yes	Napropamide	15299-99-7					1.6E+03	6.4E+03		1.3E+03	
				1.1E-02	C	1.4E-05	C			0.04		1	Yes	Nickel Carbonyl	13463-39-3					1.7E+02	1.0E+03		1.5E+02	
				1.1E-02	C	2.0E-05	C			1		1	Yes	Nickel Oxide	1313-99-1					1.7E+02	2.6E+04		1.7E+02	
		2.4E-04	I	1.1E-02	C	1.4E-05	C			0.04			Yes	Nickel Refinery Dust	NA					1.7E+02	5.2E+03		1.7E+02	
		2.6E-04	C	2.0E-02	I	9.0E-05	A			0.04		1	Yes	Nickel Soluble Salts	7440-02-0					3.1E+02	9.5E+03		3.0E+02	
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C			0.04		1	Yes	Nickel Subsulfide	12035-72-2	4.0E-02	1.5E+00		3.9E-02	1.7E+02	5.2E+03		1.7E+02	
				1.6E+00	I					1		1	Yes	Nitrate	14797-55-8					2.5E+04	3.8E+06		2.5E+04	1.0E+04
										1			Yes	Nitrate + Nitrite (as N)	NA									1.0E+04
				1.0E-01	I					1		1	Yes	Nitrite	14797-65-0					1.6E+03	2.4E+05		1.6E+03	1.0E+03
				1.0E-02	X	5.0E-05	X			1	1.85	1	Yes	Nitroaniline, 2-	88-74-4					1.6E+02	2.4E+03		1.5E+02	
2.0E-02	P			4.0E-03	P	6.0E-03	P			1	1.39	1	Yes	Nitroaniline, 4-	100-01-6	3.4E+00	1.1E+02		3.3E+00	6.3E+01	2.0E+03		6.1E+01	
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		1	1.85	1	Yes	Nitrobenzene	98-95-3			1.2E-01	1.2E-01	3.1E+01	4.4E+02	1.9E+01	1.1E+01	
				3.0E+03	P					1	-4.56	1	No	Nitrocellulose	9004-70-0					4.7E+07			4.7E+07	
				7.0E-02	H					1	-0.47	1	Yes	Nitrofurantoin	67-20-9					1.1E+03	1.1E+06		1.1E+03	
1.3E+00	C	3.7E-04	C							1	0.23	1	Yes	Nitrofurazone	59-87-0	5.2E-02	1.4E+01		5.2E-02					
1.7E-02	P			1.0E-04	P					1	1.62	1	Yes	Nitroglycerin	55-63-0	4.0E+00	1.6E+02		3.9E+00	1.6E+00	6.2E+01		1.5E+00	
				1.0E-01	I					1	-0.89	1	Yes	Nitroguanidine	556-88-7					1.6E+03	1.3E+06		1.6E+03	
		9.0E-06	P			2.0E-02	P	V		1	-0.35	1	Yes	Nitromethane	75-52-5			5.4E-01	5.4E-01			4.2E+01	4.2E+01	
		2.7E-03	H			2.0E-02	I	V		1	0.93	1	Yes	Nitropropane, 2-	79-46-9			1.8E-03	1.8E-03			4.2E+01	4.2E+01	
2.7E+01	C	7.7E-03	C						M	1	0.23	1	Yes	Nitroso-N-ethylurea, N-	759-73-9	8.0E-04	1.4E-01		7.9E-04					
1.2E+02	C	3.4E-02	C						M	1	-0.03	1	Yes	Nitroso-N-methylurea, N-	684-93-5	1.8E-04	4.3E-02		1.8E-04					
5.4E+00	I	1.6E-03	I					V		1	2.63	1	Yes	Nitroso-di-N-butylamine, N-	924-16-3	1.2E-02	6.7E-02	3.0E-03	2.4E-03					
7.0E+00	I	2.0E-03	C							1	1.36	1	Yes	Nitroso-di-N-propylamine, N-	621-64-7	9.6E-03	3.0E-01		9.3E-03					
2.8E+00	I	8.0E-04	C							1	-1.28	1	Yes	Nitrosodiethanolamine, N-	1116-54-7	2.4E-02	6.9E+01		2.4E-02					
1.5E+02	I	4.3E-02	I						M	1	0.48	1	Yes	Nitrosodiethylamine, N-	55-18-5	1.4E-04	1.6E-02		1.4E-04					
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	1	-0.57	1	Yes	Nitrosodimethylamine, N-	62-75-9	4.2E-04	1.9E-01		4.2E-04	1.3E-01	4.9E+01		1.2E-01	
4.9E-03	I	2.6E-06	C							1	3.13	1	Yes	Nitrosodiphenylamine, N-	86-30-6	1.4E+01	4.4E+01		1.0E+01					
2.2E+01	I	6.3E-03	C							1	0.04	1	Yes	Nitrosomethylethylamine, N-	10595-95-6	3.1E-03	5.5E-01		3.0E-03					
6.7E+00	C	1.9E-03	C							1	-0.44	1	Yes	Nitrosomorpholine [N-]	59-89-2	1.0E-02	4.5E+00		1.0E-02					
9.4E+00	C	2.7E-03	C							1	0.36	1	Yes	Nitrosopiperidine [N-]	100-75-4	7.2E-03	9.3E-01		7.1E-03					
2.1E+00	I	6.1E-04	I							1	-0.19	1	Yes	Nitrosopyrrolidine, N-	930-55-2	3.2E-02	8.8E+00		3.2E-02					
				1.0E-04	X					1	2.45	1	Yes	Nitrotoluene, m-	99-08-1					1.6E+00	9.7E+00		1.3E+00	
2.2E-01	P			9.0E-04	P			V		1	2.3	1	Yes	Nitrotoluene, o-	88-72-2	3.1E-01	2.4E+00		2.7E-01	1.4E+01	1.1E+02		1.2E+01	
1.6E-02	P			4.0E-03	P					1	2.37	1	Yes	Nitrotoluene, p-	99-99-0	4.2E+00	2.9E+01		3.7E+00	6.3E+01	4.4E+02		5.5E+01	
				3.0E-04	X	2.0E-01	P	V		1	5.65	1	No	Nonane, n-	111-84-2					4.7E+00		4.2E+02	4.6E+00	
				4.0E-02	I					1	2.3	1	Yes	Norflurazon	27314-13-2					6.3E+02	1.4E+04		6.0E+02	
				7.0E-04	I					1	3.7	0.9	Yes	Nustar	85509-19-9					1.1E+01	3.5E+01		8.3E+00	
				3.0E-03	I					1	8.71	0.3	No	Octabromodiphenyl Ether	32536-52-0					4.7E+01			4.7E+01	
				5.0E-02	I					1	0.16	1	Yes	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					7.8E+02	4.5E+05		7.8E+02	
				2.0E-03	H					1	-1.01	1	Yes	Octamethylpyrophosphoramide	152-16-9					3.1E+01	1.0E+05		3.1E+01	
				1.0E-02	P					1	8.1	0	No	Octyl Phthalate, di-N-	117-84-0					1.6E+02			1.6E+02	
				5.0E-02	I					1	3.73	0.9	Yes	Oryzalin	19044-88-3					7.8E+02	2.9E+03		6.2E+02	
				5.0E-03	I					1	4.8	0.8	Yes	Oxadiazon	19666-30-9					7.8E+01	6.4E+01		3.5E+01	
				2.5E-02	I					1	-0.47	1	Yes	Oxamyl	23135-22-0					3.9E+02	3.6E+05		3.9E+02	2.0E+02
				1.3E-02	I					1	3.2	0.9	Yes	Paclobutrazol	76738-62-0					2.0E+02	1.2E+03		1.7E+02	
				4.5E-03	I					1	-4.5	1	No	Paraquat Dichloride	1910-42-5					7.0E+01			7.0E+01	
				6.0E-03	H					1	3.83	0.9	Yes	Parathion	56-38-2					9.4E+01	2.1E+02		6.5E+01	
				5.0E-02	H					1	3.83	1	Yes	Pebulate	1114-71-2					7.8E+02	9.0E+02		4.2E+02	
				4.0E-02	I					1	5.18	0.9	Yes	Pendimethalin	40487-42-1					6.3E+02	1.7E+02		1.3E+02	
				2.0E-03	I					1	6.84	0.6	No	Pentabromodiphenyl Ether	32534-81-9					3.1E+01			3.1E+01	
				1.0E-04	I					1	6.84	0.6	No	Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					1.6E+00			1.6E+00	
				8.0E-04	I					1	5.17	0.9	Yes	Pentachlorobenzene	608-93-5					1.3E+01	2.8E+00		2.3E+00	
9.0E-02	P									1	3.22	1	Yes	Pentachloroethane	76-01-7	7.5E-01	2.2E+00		5.6E-01					

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO ($(mg/kg-day)^{-1}$)	key	IUR ($(ug/m^3)^{-1}$)	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
2.6E-01	H			3.0E-03	I					1	4.64	0.9	Yes	Pentachloronitrobenzene	82-68-8	2.6E-01	1.7E-01		1.0E-01	4.7E+01	3.1E+01		1.9E+01	
4.0E-01	I	5.1E-06	C	5.0E-03	I					1	5.12	0.9	Yes	Pentachlorophenol	87-86-5	1.7E-01	4.5E-02		3.5E-02	7.8E+01	2.1E+01		1.6E+01	1.0E+00
4.0E-03	X			2.0E-03	P					1	2.38	1	Yes	Pentaerythritol tetranitrate (PETN)	78-11-5	1.7E+01	3.7E+02		1.6E+01	3.1E+01	6.8E+02		3.0E+01	
						1.0E+00	P	V		1	3.39	1	Yes	Pentane, n-	109-66-0							2.1E+03	2.1E+03	
														Perchlorates										
				7.0E-04	I					1		1	Yes	~Ammonium Perchlorate	7790-98-9					1.1E+01	1.7E+03		1.1E+01	
				7.0E-04	I					1		1	Yes	~Lithium Perchlorate	7791-03-9					1.1E+01	1.7E+03		1.1E+01	
				7.0E-04	I					1		1	Yes	~Perchlorate and Perchlorate Salts	14797-73-0					1.1E+01	1.7E+03		1.1E+01	1.5E+01(F)
				7.0E-04	I					1		1	Yes	~Potassium Perchlorate	7778-74-7					1.1E+01	8.3E+02		1.1E+01	
				7.0E-04	I					1		1	Yes	~Sodium Perchlorate	7601-89-0					1.1E+01	1.7E+03		1.1E+01	
				5.0E-02	I					1	6.5	0.6	No	Permethrin	52645-53-1					7.8E+02			7.8E+02	
2.2E-03	C	6.3E-07	C							1	1.58	1	Yes	Phenacetin	62-44-2	3.1E+01	9.4E+02		3.0E+01					
				2.5E-01	I					1	3.59	0.9	Yes	Phenmedipham	13684-63-4					3.9E+03	1.3E+04		3.0E+03	
				3.0E-01	I	2.0E-01	C			1	1.46	1	Yes	Phenol	108-95-2					4.7E+03	9.6E+04		4.5E+03	
				5.0E-04	X					1	4.15	1	Yes	Phenothiazine	92-84-2					7.8E+00	5.4E+00		3.2E+00	
				6.0E-03	I					1	-0.33	1	Yes	Phenylenediamine, m-	108-45-2					9.4E+01	3.4E+04		9.4E+01	
4.7E-02	H									1	0.15	1	Yes	Phenylenediamine, o-	95-54-5	1.4E+00	2.5E+02		1.4E+00					
				1.9E-01	H					1	-0.3	1	Yes	Phenylenediamine, p-	106-50-3					3.0E+03	1.0E+06		3.0E+03	
1.9E-03	H									1	3.09	1	Yes	Phenylphenol, 2-	90-43-7	3.5E+01	1.0E+02		2.6E+01					
				2.0E-04	H					1	3.56	0.9	Yes	Phorate	298-02-2					3.1E+00	8.7E+00		2.3E+00	
						3.0E-04	I	V		1				Phosgene	75-44-5									
				2.0E-02	I					1	2.78	1	Yes	Phosmet	732-11-6					3.1E+02	3.7E+03		2.9E+02	
														Phosphates, Inorganic										
				4.9E+01	P					1		1	Yes	~Aluminum metaphosphate	13776-88-0					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Ammonium polyphosphate	68333-79-9					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Calcium pyrophosphate	7790-76-3					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Diammonium phosphate	7783-28-0					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Dicalcium phosphate	7757-93-9					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Dimagnesium phosphate	7782-75-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Dipotassium phosphate	7758-11-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Disodium phosphate	7558-79-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monoaluminum phosphate	13530-50-2					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monoammonium phosphate	7722-76-1					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monocalcium phosphate	7758-23-8					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monomagnesium phosphate	7757-86-0					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monopotassium phosphate	7778-77-0					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Monosodium phosphate	7558-80-7					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Polyphosphoric acid	8017-16-1					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Potassium tripolyphosphate	13845-36-8					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Sodium acid pyrophosphate	7758-16-9					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Sodium aluminum phosphate (acidic)	7785-88-8					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Sodium aluminum phosphate (anhydrous)	10279-59-1					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		0.9	Yes	~Sodium hexametaphosphate	10124-56-8					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Sodium polyphosphate	68915-31-1					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Sodium trimetaphosphate	7785-84-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Sodium tripolyphosphate	7758-29-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Tetrapotassium phosphate	7320-34-5					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Tetrasodium pyrophosphate	7722-88-5					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1			Yes	~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Tricalcium phosphate	7758-87-4					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Trimagnesium phosphate	7757-87-1					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Tripotassium phosphate	7778-53-2					7.6E+05	1.2E+08		7.6E+05	
				4.9E+01	P					1		1	Yes	~Trisodium phosphate	7601-54-9					7.6E+05	1.2E+08		7.6E+05	
				3.0E-04	I	3.0E-04	I			1		1	Yes	Phosphine	7803-51-2					4.7E+00	7.1E+02		4.7E+00	
				4.9E+01	P	1.0E-02	I			1		1	Yes	Phosphoric Acid	7664-38-2					7.6E+05	1.2E+08		7.6E+05	
				2.0E-05	I					1		1	Yes	Phosphorus, White	7723-14-0					3.1E-01	4.7E+01		3.1E-01	
				1.0E+00	H					1	2	1	Yes	Phthalic Acid, P-	100-21-0					1.6E+04	2.3E+05		1.5E+04	
				2.0E+00	I	2.0E-02	C			1	1.6	1	Yes	Phthalic Anhydride	85-44-9					3.1E+04	7.6E+05		3.0E+04	
				7.0E-02	I					1	1.9	1	Yes	Picloram	1918-02-1					1.1E+03	3.1E+04		1.1E+03	5.0E+02
				1.0E-04	X					1	0.93	1	Yes	Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					1.6E+00	1.5E+02		1.5E+00	
				1.0E-02	I					1	4.2	0.9	Yes	Pirimiphos, Methyl	29232-93-7					1.6E+02	2.2E+02		9.1E+01	
3.0E+01	C	8.6E-03	C	7.0E-06	H					1			No	Polybrominated Biphenyls	59536-65-1	2.2E-03			2.2E-03	1.1E-01			1.1E-01	
														Polychlorinated Biphenyls (PCBs)										
7.0E-02	S	2.0E-05	S	7.0E-05	I					1	5.62	0.9	No	~Aroclor 1016	12674-11-2	9.6E-01			9.6E-01	1.1E+00			1.1E+00	

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Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
2.0E+00	S	5.7E-04	S					V		1	4.65	1	Yes	~Aroclor 1221	11104-28-2	3.4E-02	1.0E-02	8.5E-03	4.0E-03					
2.0E+00	S	5.7E-04	S					V		1	4.65	1	Yes	~Aroclor 1232	11141-16-5	3.4E-02	1.0E-02	8.5E-03	4.0E-03					
2.0E+00	S	5.7E-04	S							1	6.29	0.7	No	~Aroclor 1242	53469-21-9	3.4E-02			3.4E-02					
2.0E+00	S	5.7E-04	S							1	6.2	0.7	No	~Aroclor 1248	12672-29-6	3.4E-02			3.4E-02					
2.0E+00	S	5.7E-04	S	2.0E-05	I					1	6.5	0.5	No	~Aroclor 1254	11097-69-1	3.4E-02			3.4E-02	3.1E-01			3.1E-01	
2.0E+00	S	5.7E-04	S							1	7.55	0	No	~Aroclor 1260	11096-82-5	3.4E-02			3.4E-02					
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	8.27	0	No	~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	7.5	0	No	~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	7.6	0	No	~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	7.6	0	No	~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E			1	7.41	0.1	No	~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.7E-05			1.7E-05	3.7E-04			3.7E-04	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	6.98	0.4	No	~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	7.12	0.3	No	~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	6.79	0.5	No	~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			1	6.98	0.4	No	~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.7E-02			1.7E-02	3.7E-01			3.7E-01	
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E			1	6.98	0.4	No	~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	5.2E-06			5.2E-06	1.1E-04			1.1E-04	
2.0E+00	I	5.7E-04	I							1				~Polychlorinated Biphenyls (high risk)	1336-36-3									
4.0E-01	I	1.0E-04	I							1	7.1	0.7	No	~Polychlorinated Biphenyls (low risk)	1336-36-3	1.7E-01			1.7E-01					5.0E-01
7.0E-02	I	2.0E-05	I							1				~Polychlorinated Biphenyls (lowest risk)	1336-36-3									
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			1	6.63	0.6	No	~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	5.2E-03			5.2E-03	1.1E-01			1.1E-01	
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E			1	6.34	0.7	No	~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.7E-03			1.7E-03	3.7E-02			3.7E-02	
						6.0E-04	I			1	10.46	0	No	Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9									
														Polynuclear Aromatic Hydrocarbons (PAHs)										
				6.0E-02	I			V		1	3.92	1	Yes	~Acenaphthene	83-32-9					9.4E+02	6.8E+02		4.0E+02	
				3.0E-01	I			V		1	4.45	1	Yes	~Anthracene	120-12-7					4.7E+03	1.8E+03		1.3E+03	
7.3E-01	E	1.1E-04	C						M	1	5.76	1	No	~Benz[a]anthracene	56-55-3	2.9E-02			2.9E-02					
1.2E+00	C	1.1E-04	C							1	6.11	0.9	No	~Benzo(j)fluoranthene	205-82-3	5.6E-02			5.6E-02					
7.3E+00	I	1.1E-03	C						M	1	6.13	1	No	~Benzo[a]pyrene	50-32-8	2.9E-03			2.9E-03					2.0E-01
7.3E-01	E	1.1E-04	C						M	1	5.78	1	No	~Benzo[b]fluoranthene	205-99-2	2.9E-02			2.9E-02					
7.3E-02	E	1.1E-04	C						M	1	6.11	0.9	No	~Benzo[k]fluoranthene	207-08-9	2.9E-01			2.9E-01					
7.3E-03	E	1.1E-05	C						M	1	5.81	1	No	~Chrysene	218-01-9	2.9E+00			2.9E+00					
7.3E+00	E	1.2E-03	C						M	1	6.75	0.6	No	~Dibenz[a,h]anthracene	53-70-3	2.9E-03			2.9E-03					
1.2E+01	C	1.1E-03	C							1	7.71	0.3	No	~Dibenzo(a,e)pyrene	192-65-4	5.6E-03			5.6E-03					
2.5E+02	C	7.1E-02	C						M	1	5.8	0.9	No	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	8.6E-05			8.6E-05					
				4.0E-02	I					1	5.16	1	No	~Fluoranthene	206-44-0					6.3E+02			6.3E+02	
				4.0E-02	I			V		1	4.18	1	Yes	~Fluorene	86-73-7					6.3E+02	3.3E+02		2.2E+02	
7.3E-01	E	1.1E-04	C						M	1	6.7	0.6	No	~Indeno[1,2,3-cd]pyrene	193-39-5	2.9E-02			2.9E-02					
2.9E-02	P			7.0E-02	A			V		1	3.87	1	Yes	~Methylnaphthalene, 1-	90-12-0	2.3E+00	1.7E+00		9.7E-01	1.1E+03	7.9E+02		4.6E+02	
				4.0E-03	I			V		1	3.86	1	Yes	~Methylnaphthalene, 2-	91-57-6					6.3E+01	4.6E+01		2.7E+01	
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		1	3.3	1	Yes	~Naphthalene	91-20-3			1.4E-01	1.4E-01	3.1E+02	5.0E+02	6.3E+00	6.1E+00	
1.2E+00	C	1.1E-04	C							1	4.75	0.9	Yes	~Nitropyrene, 4-	57835-92-4	5.6E-02	2.3E-02		1.6E-02					
				3.0E-02	I			V		1	4.88	1	Yes	~Pyrene	129-00-0					4.7E+02	1.1E+02		8.7E+01	
1.5E-01	I			9.0E-03	I					1	4.1	0.9	Yes	Prochloraz	67747-09-5	4.5E-01	1.2E+00		3.2E-01	1.4E+02	3.6E+02		1.0E+02	
				6.0E-03	H					1	5.58	0.8	Yes	Profluralin	26399-36-0					9.4E+01	2.3E+01		1.9E+01	
				1.5E-02	I					1	2.99	1	Yes	Prometon	1610-18-0					2.3E+02	1.1E+03		1.9E+02	
				4.0E-03	I					1	3.51	0.9	Yes	Prometryn	7287-19-6					6.3E+01	1.7E+02		4.5E+01	
				1.3E-02	I					1	2.18	1	Yes	Propachlor	1918-16-7					2.0E+02	3.1E+03		1.9E+02	
				5.0E-03	I					1	3.07	1	Yes	Propanil	709-98-8					7.8E+01	3.1E+02		6.3E+01	
				2.0E-02	I					1	5	0.8	Yes	Propargite	2312-35-8					3.1E+02	1.9E+02		1.2E+02	
				2.0E-03	I					1	-0.38	1	Yes	Propargyl Alcohol	107-19-7					3.1E+01	7.8E+03		3.1E+01	
				2.0E-02	I					1	2.93	1	Yes	Propazine	139-40-2					3.1E+02	1.7E+03		2.6E+02	
				2.0E-02	I					1	2.6	1	Yes	Propham	122-42-9					3.1E+02	2.0E+03		2.7E+02	
				1.3E-02	I					1	3.72	0.9	Yes	Propiconazole	60207-90-1					2.0E+02	7.5E+02		1.6E+02	
						8.0E-03	I	V		1	0.59	1	Yes	Propionaldehyde	123-38-6							1.7E+01	1.7E+01	
				1.0E-01	X	1.0E+00	X	V		1	3.69	1	Yes	Propyl benzene	103-65-1					1.6E+03	1.3E+03	2.1E+03	5.3E+02	
						3.0E+00	C	V		1	1.77	1	Yes	Propylene	115-07-1							6.3E+03	6.3E+03	
				2.0E+01	P					1	-0.92	1	Yes	Propylene Glycol	57-55-6					3.1E+05	2.1E+08		3.1E+05	
						2.7E-04	A			1	1.59	1	Yes	Propylene Glycol Dinitrate	6423-43-4									
				7.0E-01	H					1	0	1	Yes	Propylene Glycol Monoethyl Ether	1569-02-4					1.1E+04	2.2E+06		1.1E+04	
				7.0E-01	H	2.0E+00	I			1	-0.49	1	Yes	Propylene Glycol Monomethyl Ether	107-98-2					1.1E+04	2.7E+06		1.1E+04	
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1	0.03	1	Yes	Propylene Oxide	75-56-9	2.8E-01	4.0E+01	1.3E+00	2.3E-01			6.3E+01	6.3E+01	
				2.5E-01	I					1	2.6	1	Yes	Pursuit	81335-77-5					3.9E+03	5.1E+04		3.6E+03	
				2.5E-02	I					1	6.2	0.7	No	Pydrin	51630-58-1					3.9E+02			3.9E+02	
				1.0E-03	I			V		1	0.65	1	Yes	Pyridine	110-86-1					1.6E+01	9.9E+02		1.5E+01	
				5.0E-04	I					1	4.44	0.9	Yes	Quinalphos	13593-03-8					7.8E+00	7.3E+00		3.8E+00	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information													Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
3.0E+00	I									1	2.03	1	Yes	Quinoline	91-22-5	2.2E-02	2.5E-01		2.1E-02					
						3.0E-02	A			1			Yes	Refractory Ceramic Fibers	NA									
				3.0E-02	I					1	6.14	0.7	Yes	Resmethrin	10453-86-8					4.7E+02	5.4E+01		4.8E+01	
				5.0E-02	H					1	4.88	0.8	Yes	Ronnel	299-84-3					7.8E+02	4.8E+02		3.0E+02	
				4.0E-03	I					1	4.1	0.9	Yes	Rotenone	83-79-4					6.3E+01	1.8E+02		4.7E+01	
2.2E-01	C	6.3E-05	C						M	1	3.45	1	Yes	Safrole	94-59-7	9.8E-02	5.6E-01		8.3E-02					
				2.5E-02	I					1	5.57	0.8	Yes	Savey	78587-05-0					3.9E+02	1.0E+02		8.1E+01	
				5.0E-03	I					1		1	Yes	Selenious Acid	7783-00-8					7.8E+01	1.2E+04		7.8E+01	
				5.0E-03	I	2.0E-02	C			1		1	Yes	Selenium	7782-49-2					7.8E+01	1.2E+04		7.8E+01	5.0E+01
				5.0E-03	C	2.0E-02	C			1		1	Yes	Selenium Sulfide	7446-34-6					7.8E+01	1.2E+04		7.8E+01	
				9.0E-02	I					1	4.38	0.9	Yes	Sethoxydim	74051-80-2					1.4E+03	1.7E+03		7.8E+02	
						3.0E-03	C			1		1	Yes	Silica (crystalline, respirable)	7631-86-9									
				5.0E-03	I					0.04		1	Yes	Silver	7440-22-4					7.8E+01	7.9E+02		7.1E+01	
1.2E-01	H			5.0E-03	I					1	2.18	1	Yes	Simazine	122-34-9	5.6E-01	7.9E+00		5.2E-01	7.8E+01	1.1E+03		7.3E+01	4.0E+00
				1.3E-02	I					1	0.37	1	Yes	Sodium Acifluorfen	62476-59-9					2.0E+02	1.5E+05		2.0E+02	
				4.0E-03	I					1		1	Yes	Sodium Azide	26628-22-8					6.3E+01	9.5E+03		6.2E+01	
2.7E-01	H			3.0E-02	I					1	-1.431	1	Yes	Sodium Diethyldithiocarbamate	148-18-5	2.5E-01	7.3E+02		2.5E-01	4.7E+02	1.4E+06		4.7E+02	
				5.0E-02	A	1.3E-02	C			1		1	Yes	Sodium Fluoride	7681-49-4					7.8E+02	1.2E+05		7.8E+02	
				2.0E-05	I					1	-3.78	1	No	Sodium Fluoroacetate	62-74-8					3.1E-01			3.1E-01	
				1.0E-03	H					1		1	Yes	Sodium Metavanadate	13718-26-8					1.6E+01	2.4E+03		1.6E+01	
2.4E-02	H			3.0E-02	I					1	3.53	0.9	Yes	Stirofos (Tetrachlorovinphos)	961-11-5	2.8E+00	1.6E+01		2.4E+00	4.7E+02	2.7E+03		4.0E+02	
				6.0E-01	I					1		1	Yes	Strontium, Stable	7440-24-6					9.4E+03	1.4E+06		9.3E+03	
				3.0E-04	I					1	1.93	1	Yes	Strychnine	57-24-9					4.7E+00	2.3E+02		4.6E+00	
				2.0E-01	I	1.0E+00	I	V		1	2.95	1	Yes	Styrene	100-42-5					3.1E+03	7.1E+03	2.1E+03	1.1E+03	1.0E+02
				1.0E-03	P	2.0E-03	P			1	-0.77	1	Yes	Sulfolane	126-33-0					1.6E+01	1.2E+04		1.6E+01	
				8.0E-04	P					1	3.9	0.9	Yes	Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					1.3E+01	2.5E+01		8.3E+00	
						1.0E-03	C			1		1	Yes	Sulfuric Acid	7664-93-9									
				2.5E-02	I					1	2.94	0.9	Yes	Systhane	88671-89-0					3.9E+02	3.4E+03		3.5E+02	
				3.0E-02	H					1	3.3	0.9	Yes	TCMTB	21564-17-0					4.7E+02	1.7E+03		3.7E+02	
				7.0E-02	I					1	1.79	1	Yes	Tebuthiuron	34014-18-1					1.1E+03	3.3E+04		1.1E+03	
				2.0E-02	H					1	5.96	0.7	No	Temephos	3383-96-8					3.1E+02			3.1E+02	
				1.3E-02	I					1	1.89	1	Yes	Terbacil	5902-51-2					2.0E+02	4.9E+03		2.0E+02	
				2.5E-05	H					1	4.48	0.9	Yes	Terbufos	13071-79-9					3.9E-01	3.2E-01		1.8E-01	
				1.0E-03	I					1	3.74	0.9	Yes	Terbutryn	886-50-0					1.6E+01	2.9E+01		1.0E+01	
				1.0E-04	I					1	6.77	0.6	No	Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					1.6E+00			1.6E+00	
				3.0E-04	I					1	4.64	1	Yes	Tetrachlorobenzene, 1,2,4,5-	95-94-3					4.7E+00	1.7E+00		1.2E+00	
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		1	2.93	1	Yes	Tetrachloroethane, 1,1,1,2-	630-20-6	2.6E+00	9.3E+00	6.6E-01	5.0E-01	4.7E+02	1.7E+03		3.7E+02	
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		1	2.39	1	Yes	Tetrachloroethane, 1,1,2,2-	79-34-5	3.4E-01	2.8E+00	8.4E-02	6.6E-02	3.1E+02	2.6E+03		2.8E+02	
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		1	3.4	1	Yes	Tetrachloroethylene	127-18-4	3.2E+01	5.6E+01	1.9E+01	9.7E+00	9.4E+01	1.6E+02	8.3E+01	3.5E+01	5.0E+00
				3.0E-02	I					1	4.45	0.9	Yes	Tetrachlorophenol, 2,3,4,6-	58-90-2					4.7E+02	2.8E+02		1.7E+02	
2.0E+01	H									1	4.54	0.9	Yes	Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	3.4E-03	1.7E-03		1.1E-03					
				5.0E-04	I					1	3.99	0.9	Yes	Tetraethyl Dithiopyrophosphate	3689-24-5					7.8E+00	1.7E+01		5.3E+00	
						8.0E+01	I	V		1	1.68	1	Yes	Tetrafluoroethane, 1,1,1,2-	811-97-2							1.7E+05	1.7E+05	
				4.0E-03	P					1	1.64	1	Yes	Tetryl (Trinitrophenylmethylnitramine)	479-45-8					6.3E+01	3.5E+03		6.1E+01	
				7.0E-06	X					1		1	Yes	Thallium (I) Nitrate	10102-45-1					1.1E-01	1.7E+01		1.1E-01	
				1.0E-05	X					1		1	Yes	Thallium (Soluble Salts)	7440-28-0					1.6E-01	2.4E+01		1.6E-01	2.0E+00
				6.0E-06	X					1		1	Yes	Thallium Acetate	563-68-8					9.4E-02	1.4E+01		9.3E-02	
				2.0E-05	X					1		0.9	Yes	Thallium Carbonate	6533-73-9					3.1E-01	4.7E+01		3.1E-01	
				6.0E-06	X					1		1	Yes	Thallium Chloride	7791-12-0					9.4E-02	1.4E+01		9.3E-02	
				2.0E-05	X					1		0.9	Yes	Thallium Sulfate	7446-18-6					3.1E-01	4.7E+01		3.1E-01	
				1.0E-02	I					1	3.4	0.9	Yes	Thiobencarb	28249-77-6					1.6E+02	5.5E+02		1.2E+02	
				7.0E-02	X					1	-0.63	1	Yes	Thiodiglycol	111-48-8					1.1E+03	6.8E+05		1.1E+03	
				3.0E-04	H					1	2.75	1	Yes	Thiofanox	39196-18-4					4.7E+00	3.1E+01		4.1E+00	
				8.0E-02	I					1	1.4	1	Yes	Thiophanate, Methyl	23564-05-8					1.3E+03	1.5E+05		1.2E+03	
				5.0E-03	I					1	1.73	1	Yes	Thiram	137-26-8					7.8E+01	2.8E+03		7.6E+01	
				6.0E-01	H					1		1	Yes	Tin	7440-31-5					9.4E+03	1.4E+06		9.3E+03	
						1.0E-04	A			1		1	Yes	Titanium Tetrachloride	7550-45-0									
				8.0E-02	I	5.0E+00	I	V		1	2.73	1	Yes	Toluene	108-88-3					1.3E+03	3.7E+03	1.0E+04	8.6E+02	1.0E+03
1.8E-01	X			2.0E-04	X					1	0.16	1	Yes	Toluene-2,5-diamine	95-70-5	3.7E-01	7.0E+01		3.7E-01	3.1E+00	5.9E+02		3.1E+00	
3.0E-02	P			4.0E-03	X					1	1.39	1	Yes	Toluidine, p-	106-49-0	2.2E+00	5.8E+01		2.2E+00	6.3E+01	1.6E+03		6.0E+01	
1.1E+00	I	3.2E-04	I							1	5.78	0.8	Yes	Toxaphene	8001-35-2	6.1E-02	1.7E-02		1.3E-02					3.0E+00
				7.5E-03	I					1	7.56	0.5	No	Tralomethrin	66841-25-6					1.2E+02			1.2E+02	
				3.0E-04	A					1	4.1	0.9	Yes	Tri-n-butyltin	688-73-3					4.7E+00	7.0E+00		2.8E+00	
				8.0E+01	X					1	0.25	1	Yes	Triacetin	102-76-1					1.3E+06	3.8E+08		1.2E+06	
				1.3E-02	I					1	4.6	0.9	Yes	Triallate	2303-17-5					2.0E+02	1.5E+02		8.7E+01	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	GIABS	LOGP	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)
				1.0E-02	I					1	1.1	1	Yes	Triasulfuron	82097-50-5					1.6E+02	4.2E+04		1.6E+02	
				5.0E-03	I					1	4.66	0.9	Yes	Tribromobenzene, 1,2,4-	615-54-3					7.8E+01	5.7E+01		3.3E+01	
9.0E-03	P			1.0E-02	P					1	4	0.9	Yes	Tributyl Phosphate	126-73-8	7.5E+00	1.1E+01		4.5E+00	1.6E+02	2.3E+02		9.3E+01	
				3.0E-04	P					1			No	Tributyltin Compounds	NA					4.7E+00			4.7E+00	
				3.0E-04	I					1	3.84	1	Yes	Tributyltin Oxide	56-35-9					4.7E+00	6.7E+01		4.4E+00	
				3.0E+01	I	3.0E+01	H	V		1	3.16	1	Yes	Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					4.7E+05	1.4E+06	6.3E+04	5.3E+04	
7.0E-02	I			2.0E-02	I					1	1.33	1	Yes	Trichloroacetic Acid	76-03-9	9.6E-01	3.9E+01		9.4E-01	3.1E+02	1.3E+04		3.1E+02	6.0E+01
2.9E-02	H									1	-0.67	1	Yes	Trichloroaniline HCl, 2,4,6-	33663-50-2	2.3E+00	3.2E+03		2.3E+00					
7.0E-03	X			3.0E-05	X					1	3.52	1	Yes	Trichloroaniline, 2,4,6-	634-93-5	9.6E+00	1.7E+01		6.1E+00	4.7E-01	8.3E-01		3.0E-01	
				8.0E-04	X			V		1	4.05	1	Yes	Trichlorobenzene, 1,2,3-	87-61-6					1.3E+01	8.9E+00		5.2E+00	
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1	4.02	1	Yes	Trichlorobenzene, 1,2,4-	120-82-1	2.3E+00	1.7E+00		9.9E-01	1.6E+02	1.2E+02	4.2E+00	3.9E+00	7.0E+01
				2.0E+00	I	5.0E+00	I	V		1	2.49	1	Yes	Trichloroethane, 1,1,1-	71-55-6					3.1E+04	1.8E+05	1.0E+04	7.5E+03	2.0E+02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1	1.89	1	Yes	Trichloroethane, 1,1,2-	79-00-5	1.2E+00	1.7E+01	3.0E-01	2.4E-01	6.3E+01	8.9E+02	4.2E-01	4.1E-01	5.0E+00
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	1	2.42	1	Yes	Trichloroethylene	79-01-6	1.0E+00	6.6E+00	8.6E-01	4.4E-01	7.8E+00	4.9E+01	4.2E+00	2.6E+00	5.0E+00
				3.0E-01	I	7.0E-01	H	V		1	2.53	1	Yes	Trichlorofluoromethane	75-69-4					4.7E+03	2.6E+04	1.5E+03	1.1E+03	
				1.0E-01	I					1	3.72	1	Yes	Trichlorophenol, 2,4,5-	95-95-4					1.6E+03	2.0E+03		8.9E+02	
1.1E-02	I	3.1E-06	I	1.0E-03	P					1	3.69	1	Yes	Trichlorophenol, 2,4,6-	88-06-2	6.1E+00	8.3E+00		3.5E+00	1.6E+01	2.1E+01		9.0E+00	
				1.0E-02	I					1	3.31	0.9	Yes	Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					1.6E+02	6.2E+02		1.2E+02	
				8.0E-03	I					1	3.8	0.9	Yes	Trichlorophenoxypropionic acid, -2,4,5	93-72-1					1.3E+02	2.6E+02		8.4E+01	5.0E+01
				5.0E-03	I			V		1	2.43	1	Yes	Trichloropropane, 1,1,2-	598-77-6					7.8E+01	5.3E+02		6.8E+01	
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1	2.27	1	Yes	Trichloropropane, 1,2,3-	96-18-4	7.2E-04	6.7E-03		6.5E-04	6.3E+01	5.4E+02	6.3E-01	6.2E-01	
				3.0E-03	X	3.0E-04	P	V		1	2.78	1	Yes	Trichloropropene, 1,2,3-	96-19-5					4.7E+01	1.8E+02	6.3E-01	6.2E-01	
				2.0E-02	A					1	5.11	0.8	Yes	Tricresyl Phosphate (TCP)	1330-78-5					3.1E+02	1.8E+02		1.2E+02	
				3.0E-03	I					1	5.18	0.8	Yes	Tridiphane	58138-08-2					4.7E+01	1.8E+01		1.3E+01	
						7.0E-03	I	V		1	1.45	1	Yes	Triethylamine	121-44-8							1.5E+01	1.5E+01	
7.7E-03	I			7.5E-03	I					1	5.34	0.8	Yes	Trifluralin	1582-09-8	8.7E+00	2.9E+00		2.2E+00	1.2E+02	3.9E+01		2.9E+01	
2.0E-02	P			1.0E-02	P					1	-0.65	1	Yes	Trimethyl Phosphate	512-56-1	3.4E+00	2.4E+03		3.4E+00	1.6E+02	1.1E+05		1.6E+02	
						5.0E-03	P	V		1	3.66	1	Yes	Trimethylbenzene, 1,2,3-	526-73-8							1.0E+01	1.0E+01	
						7.0E-03	P	V		1	3.63	1	Yes	Trimethylbenzene, 1,2,4-	95-63-6							1.5E+01	1.5E+01	
				1.0E-02	X			V		1	3.42	1	Yes	Trimethylbenzene, 1,3,5-	108-67-8					1.6E+02	2.0E+02		8.7E+01	
				3.0E-02	I					1	1.18	1	Yes	Trinitrobenzene, 1,3,5-	99-35-4					4.7E+02	3.3E+04		4.6E+02	
3.0E-02	I			5.0E-04	I					1	1.6	1	Yes	Trinitrotoluene, 2,4,6-	118-96-7	2.2E+00	9.1E+01		2.2E+00	7.8E+00	3.2E+02		7.6E+00	
				2.0E-02	P					1	2.83	1	Yes	Triphenylphosphine Oxide	791-28-6					3.1E+02	2.7E+03		2.8E+02	
				2.0E-02	A					1	3.65	0.9	Yes	Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					3.1E+02	2.3E+03		2.8E+02	
				1.0E-02	X					1	2.59	1	Yes	Tris(1-chloro-2-propyl)phosphate	13674-84-5					1.6E+02	2.7E+03		1.5E+02	
2.0E-02	P			7.0E-03	P					1	1.44	1	Yes	Tris(2-chloroethyl)phosphate	115-96-8	3.4E+00	2.5E+02		3.3E+00	1.1E+02	8.3E+03		1.1E+02	
3.2E-03	P			1.0E-01	P					1	9.49	0	No	Tris(2-ethylhexyl)phosphate	78-42-2	2.1E+01			2.1E+01	1.6E+03			1.6E+03	
				3.0E-03	I	4.0E-05	A			1		1	Yes	Uranium (Soluble Salts)	NA					4.7E+01	7.1E+03		4.7E+01	3.0E+01
1.0E+00	C	2.9E-04	C						M	1	-0.15	1	Yes	Urethane	51-79-6	2.2E-02	5.6E+00		2.1E-02					
		8.3E-03	P	9.0E-03	I	7.0E-06	P			0.026		1	Yes	Vanadium Pentoxide	1314-62-1					1.4E+02	5.5E+02		1.1E+02	
				5.0E-03	S	1.0E-04	A			0.026		1	Yes	Vanadium and Compounds	7440-62-2					7.9E+01	3.1E+02		6.3E+01	
				1.0E-03	I					1	3.84	1	Yes	Vernolate	1929-77-7					1.6E+01	1.8E+01		8.3E+00	
				2.5E-02	I					1	3.1	0.9	Yes	Vinclozolin	50471-44-8					3.9E+02	2.6E+03		3.4E+02	
				1.0E+00	H	2.0E-01	I	V		1	0.73	1	Yes	Vinyl Acetate	108-05-4					1.6E+04	9.2E+05	4.2E+02	4.1E+02	
		3.2E-05	H			3.0E-03	I	V		1	1.57	1	Yes	Vinyl Bromide	593-60-2			1.5E-01	1.5E-01			6.3E+00	6.3E+00	
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1	1.62	1	Yes	Vinyl Chloride	75-01-4	1.7E-02	2.6E-01	3.2E-01	1.5E-02	4.7E+01	5.8E+02	2.1E+02	3.6E+01	2.0E+00
				3.0E-04	I					1	2.7	1	Yes	Warfarin	81-81-2					4.7E+00	6.0E+01		4.4E+00	
				2.0E-01	S	1.0E-01	S	V		1	3.15	1	Yes	Xylene, P-	106-42-3					3.1E+03	5.3E+03	2.1E+02	1.9E+02	
				2.0E-01	S	1.0E-01	S	V		1	3.2	1	Yes	Xylene, m-	108-38-3					3.1E+03	4.9E+03	2.1E+02	1.9E+02	
				2.0E-01	S	1.0E-01	S	V		1	3.12	1	Yes	Xylene, o-	95-47-6					3.1E+03	5.5E+03	2.1E+02	1.9E+02	
				2.0E-01	I	1.0E-01	I	V		1	3.16	1	Yes	Xylenes	1330-20-7					3.1E+03	5.2E+03	2.1E+02	1.9E+02	1.0E+04
				3.0E-04	I					1		1	Yes	Zinc Phosphide	1314-84-7					4.7E+00	1.2E+03		4.7E+00	
				3.0E-01	I					1		1	Yes	Zinc and Compounds	7440-66-6					4.7E+03	1.2E+06		4.7E+03	
				5.0E-02	I					1	1.3	1	Yes	Zineb	12122-67-7					7.8E+02	6.9E+04		7.7E+02	
				8.0E-05	X					1		1	Yes	Zirconium	7440-67-7					1.3E+00	1.9E+02		1.2E+00	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information											Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
1.8E-02	C	5.1E-06	C	1.5E-01	I					ALAR	1596-84-5	3.7E+00	1.1E+04		3.7E+00	2.3E+03	7.1E+06		2.3E+03		8.2E-04	
8.7E-03	I			4.0E-03	I					Acephate	30560-19-1	7.7E+00	1.0E+04		7.7E+00	6.3E+01	8.1E+04		6.3E+01		1.7E-03	
		2.2E-06	I			9.0E-03	I	V		Acetaldehyde	75-07-0			2.2E+00	2.2E+00			1.9E+01	1.9E+01		4.5E-04	
				2.0E-02	I					Acetochlor	34256-82-1					3.1E+02	2.1E+03		2.7E+02		2.2E-01	
				9.0E-01	I	3.1E+01	A	V		Acetone	67-64-1					1.4E+04	2.9E+06	6.4E+04	1.2E+04		2.4E+00	
						2.0E-03	X	V		Acetone Cyanohydrin	75-86-5							4.2E+00	4.2E+00		8.4E-04	
						6.0E-02	I	V		Acetonitrile	75-05-8							1.3E+02	1.3E+02		2.6E-02	
				1.0E-01	I			V		Acetophenone	98-86-2					1.6E+03	3.3E+04		1.5E+03		4.5E-01	
3.8E+00	C	1.3E-03	C							Acetylaminofluorene, 2-	53-96-3	1.8E-02	5.7E-02		1.3E-02						6.2E-05	
				5.0E-04	I	2.0E-05	I	V		Acrolein	107-02-8					7.8E+00	1.1E+03	4.2E-02	4.1E-02		8.4E-06	
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	Acrylamide	79-06-1	4.3E-02	2.2E+01		4.3E-02	3.1E+01	1.4E+04		3.1E+01		9.1E-06	
				5.0E-01	I	1.0E-03	I			Acrylic Acid	79-10-7					7.8E+03	7.4E+05		7.7E+03		1.6E+00	
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		Acrylonitrile	107-13-1	1.2E-01	1.2E+01	7.2E-02	4.5E-02	6.3E+02	5.8E+04	4.2E+00	4.1E+00		9.8E-06	
						6.0E-03	P			Adiponitrile	111-69-3											
5.6E-02	C			1.0E-02	I					Alachlor	15972-60-8	1.2E+00	3.8E+00		9.1E-01	1.6E+02	4.9E+02		1.2E+02	2.0E+00	7.5E-04	1.6E-03
				1.0E-03	I					Aldicarb	116-06-3					1.6E+01	1.0E+03		1.5E+01	3.0E+00	3.8E-03	7.5E-04
				1.0E-03	I					Aldicarb Sulfone	1646-88-4					1.6E+01	1.7E+04		1.6E+01	2.0E+00	3.4E-03	4.4E-04
										Aldicarb sulfoxide	1646-87-3									4.0E+00		8.8E-04
1.7E+01	I	4.9E-03	I	3.0E-05	I					Aldrin	309-00-2	4.0E-03			4.0E-03	4.7E-01			4.7E-01		6.5E-04	
				2.5E-01	I					Ally	74223-64-6					3.9E+03	1.7E+05		3.8E+03		1.5E+00	
				5.0E-03	I	1.0E-04	X			Allyl Alcohol	107-18-6					7.8E+01	8.6E+03		7.8E+01		1.6E-02	
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		Allyl Chloride	107-05-1	3.2E+00	2.9E+01	8.1E-01	6.3E-01			2.1E+00	2.1E+00		2.0E-04	
				1.0E+00	P	5.0E-03	P			Aluminum	7429-90-5					1.6E+04	2.4E+06		1.6E+04		2.3E+04	
				4.0E-04	I					Aluminum Phosphide	20859-73-8					6.3E+00	9.5E+02		6.2E+00			
				3.0E-04	I					Amdro	67485-29-4					4.7E+00	3.6E+02		4.6E+00		1.7E+03	
				9.0E-03	I					Ametryn	834-12-8					1.4E+02	6.9E+02		1.2E+02		1.2E-01	
2.1E+01	C	6.0E-03	C							Aminobiphenyl, 4-	92-67-1	3.2E-03	1.3E-02		2.6E-03						1.3E-05	
				8.0E-02	P					Aminophenol, m-	591-27-5					1.3E+03	2.0E+05		1.2E+03		4.7E-01	
				2.0E-02	P					Aminophenol, p-	123-30-8					3.1E+02	6.4E+04		3.1E+02		1.2E-01	
				2.5E-03	I					Amitraz	33089-61-1					3.9E+01	6.9E+00		5.9E+00		3.0E+00	
						1.0E-01	I			Ammonia	7664-41-7											
				2.0E-01	I					Ammonium Sulfamate	7773-06-0					3.1E+03	4.7E+05		3.1E+03			
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			Aniline	62-53-3	1.2E+01	5.9E+02		1.2E+01	1.1E+02	5.3E+03		1.1E+02		3.9E-03	
4.0E-02	P			2.0E-03	X					Anthraquinone, 9,10-	84-65-1	1.7E+00	4.3E+00		1.2E+00	3.1E+01	8.1E+01		2.3E+01		1.2E-02	
				4.0E-04	I					Antimony (metallic)	7440-36-0					6.3E+00	1.4E+02		6.0E+00	6.0E+00	2.7E-01	2.7E-01
				5.0E-04	H					Antimony Pentoxide	1314-60-9					7.8E+00	1.8E+02		7.5E+00			
				9.0E-04	H					Antimony Potassium Tartrate	11071-15-1					1.4E+01	3.2E+02		1.3E+01			
				4.0E-04	H					Antimony Tetroxide	1332-81-6					6.3E+00	1.4E+02		6.0E+00			
						2.0E-04	I			Antimony Trioxide	1309-64-4											
				1.3E-02	I					Apollo	74115-24-5					2.0E+02	1.5E+03		1.8E+02		1.1E+01	
2.5E-02	I	7.1E-06	I	5.0E-02	H					Aramite	140-57-8	2.7E+00	2.0E+00		1.1E+00	7.8E+02	5.8E+02		3.3E+02		1.3E-02	
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			Arsenic, Inorganic	7440-38-2	4.5E-02	8.3E+00		4.5E-02	4.7E+00	7.1E+02		4.7E+00	1.0E+01	1.3E-03	2.9E-01
				3.5E-06	C	5.0E-05	I			Arsine	7784-42-1					5.5E-02	8.3E+00		5.4E-02			
				9.0E-03	I					Assure	76578-14-8					1.4E+02	2.7E+02		9.3E+01		1.4E+00	
				5.0E-02	I					Asulam	3337-71-1					7.8E+02	5.7E+05		7.8E+02		2.0E-01	
2.3E-01	C			3.5E-02	I					Atrazine	1912-24-9	2.9E-01	2.3E+00		2.6E-01	5.5E+02	4.4E+03		4.9E+02	3.0E+00	1.7E-04	1.9E-03
8.8E-01	C	2.5E-04	C							Auramine	492-80-8	7.6E-02	2.3E-01		5.7E-02						5.2E-04	
				4.0E-04	I					Avermectin B1	65195-55-3					6.3E+00			6.3E+00		1.1E+01	
1.1E-01	I	3.1E-05	I					V		Azobenzene	103-33-3	6.1E-01	6.2E-01	1.6E-01	1.0E-01						8.0E-04	
				2.0E-01	I	5.0E-04	H			Barium	7440-39-3					3.1E+03	3.3E+04		2.9E+03	2.0E+03	1.2E+02	8.2E+01
				4.0E-03	I					Baygon	114-26-1					6.3E+01	2.6E+03		6.1E+01		2.0E-02	
				3.0E-02	I					Bayleton	43121-43-3					4.7E+02	4.9E+03		4.3E+02		3.4E-01	
				2.5E-02	I					Baythroid	68359-37-5					3.9E+02	1.1E+02		8.7E+01		2.3E+01	
				3.0E-01	I					Benefin	1861-40-1					4.7E+03	1.7E+03		1.2E+03		4.1E+01	
				5.0E-02	I					Benomyl	17804-35-2					7.8E+02	2.2E+04		7.5E+02		6.6E-01	
				3.0E-02	I					Bentazon	25057-89-0					4.7E+02	6.7E+03		4.4E+02		9.6E-02	
				1.0E-01	I			V		Benzaldehyde	100-52-7					1.6E+03	3.4E+04		1.5E+03		3.3E-01	
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		Benzene	71-43-2	1.2E+00	8.4E+00	6.2E-01	3.9E-01	6.3E+01	4.1E+02	6.3E+01	2.9E+01	5.0E+00	2.0E-04	2.6E-03
1.0E-01	X			3.0E-04	X					Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	6.7E-01			6.7E-01	4.7E+00			4.7E+00		1.9E-04	
				1.0E-03	P			V		Benzenethiol	108-98-5					1.6E+01	7.3E+01		1.3E+01		8.6E-03	
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	Benzidine	92-87-5	9.4E-05	4.6E-03		9.2E-05	4.7E+01	2.1E+03		4.6E+01		2.4E-07	
				4.0E+00	I					Benzoic Acid	65-85-0					6.3E+04	8.5E+05		5.8E+04		1.4E+01	
1.3E+01	I							V		Benzotrichloride	98-07-7	5.2E-03	5.1E-03		2.6E-03						5.6E-06	
				1.0E-01	P					Benzyl Alcohol	100-51-6					1.6E+03	6.3E+04		1.5E+03		3.7E-01	
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		Benzyl Chloride	100-44-7	4.0E-01	2.9E+00	9.9E-02	7.7E-02	3.1E+01	2.3E+02	2.1E+00	1.9E+00		8.4E-05	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
		2.4E-03	I	2.0E-03	I	2.0E-05	I			Beryllium and compounds	7440-41-7					3.1E+01	3.3E+01		1.6E+01	4.0E+00	1.3E+01	3.2E+00
				1.0E-04	I					Bidrin	141-66-2					1.6E+00	7.8E+02		1.6E+00		3.6E-04	
				9.0E-03	P					Bifenox	42576-02-3					1.4E+02	1.6E+02		7.5E+01		5.7E-01	
				1.5E-02	I					Biphenthrin	82657-04-3					2.3E+02			2.3E+02		1.1E+03	
8.0E-03	X			5.0E-02	I	4.0E-04	X	V		Biphenyl, 1,1'-	92-52-4	8.4E+00	5.6E+00		3.3E+00	7.8E+02	5.2E+02	8.3E-01	8.3E-01		8.7E-03	
7.0E-02	H	1.0E-05	H	4.0E-02	I			V		Bis(2-chloro-1-methylethyl) ether	108-60-1	9.6E-01	7.0E+00	4.9E-01	3.1E-01	6.3E+02	4.6E+03		5.5E+02		1.1E-04	
				3.0E-03	P					Bis(2-chloroethoxy)methane	111-91-1					4.7E+01	2.1E+03		4.6E+01		1.1E-02	
1.1E+00	I	3.3E-04	I					V		Bis(2-chloroethyl)ether	111-44-4	6.1E-02	2.3E+00	1.5E-02	1.2E-02						3.1E-06	
1.4E-02	I	2.4E-06	C	2.0E-02	I					Bis(2-ethylhexyl)phthalate	117-81-7	4.8E+00			4.8E+00	3.1E+02			3.1E+02	6.0E+00	1.1E+00	1.4E+00
2.2E+02	I	6.2E-02	I					V		Bis(chloromethyl)ether	542-88-1	3.1E-04	2.9E-02	7.8E-05	6.2E-05						1.5E-08	
				5.0E-02	I					Bisphenol A	80-05-7					7.8E+02	2.3E+03		5.8E+02		4.4E+01	
				2.0E-01	I	2.0E-02	H			Boron And Borates Only	7440-42-8					3.1E+03	4.7E+05		3.1E+03		9.9E+00	
				2.0E+00	P	2.0E-02	P			Boron Trichloride	10294-34-5					3.1E+04	4.7E+06		3.1E+04			
				4.0E-02	C	1.3E-02	C			Boron Trifluoride	7637-07-2					6.3E+02	9.5E+04		6.2E+02			
7.0E-01	I			4.0E-03	I					Bromate	15541-45-4	9.6E-02	1.8E+01		9.6E-02	6.3E+01	9.5E+03		6.2E+01	1.0E+01	7.4E-04	7.7E-02
2.0E+00	X	6.0E-04	X					V		Bromo-2-chloroethane, 1-	107-04-0	3.4E-02	4.8E-01	8.1E-03	6.4E-03						1.8E-06	
				8.0E-03	I	6.0E-02	I	V		Bromobenzene	108-86-1					1.3E+02	3.8E+02	1.3E+02	5.4E+01		3.6E-02	
						4.0E-02	X	V		Bromochloromethane	74-97-5							8.3E+01	8.3E+01		2.1E-02	
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		Bromodichloromethane	75-27-4	1.1E+00	1.6E+01	1.3E-01	1.2E-01	3.1E+02	4.6E+03		2.9E+02	8.0E+01(F)	3.2E-05	2.2E-02
7.9E-03	I	1.1E-06	I	2.0E-02	I					Bromoform	75-25-2	8.5E+00	1.2E+02		7.9E+00	3.1E+02	4.4E+03		2.9E+02	8.0E+01(F)	2.1E-03	2.1E-02
				1.4E-03	I	5.0E-03	I	V		Bromomethane	74-83-9					2.2E+01	6.8E+02	1.0E+01	7.0E+00		1.8E-03	
				5.0E-03	H					Bromophos	2104-96-3					7.8E+01	3.9E+01		2.6E+01		1.1E-01	
				2.0E-02	I					Bromoxynil	1689-84-5					3.1E+02	1.3E+03		2.5E+02		2.2E-01	
				2.0E-02	I					Bromoxynil Octanoate	1689-99-2					3.1E+02	1.5E+02		1.0E+02		8.7E-01	
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		Butadiene, 1,3-	106-99-0	2.0E-02	1.4E-01	1.6E-01	1.6E-02			4.2E+00	4.2E+00		8.6E-06	
				1.0E-01	I					Butanol, N-	71-36-3					1.6E+03	6.6E+04		1.5E+03		3.2E-01	
1.9E-03	P			2.0E-01	I					Butyl Benzyl Phthlate	85-68-7	3.5E+01	2.3E+01		1.4E+01	3.1E+03	2.0E+03		1.2E+03		2.0E-01	
				2.0E+00	P	3.0E+01	P			Butyl alcohol, sec-	78-92-2					3.1E+04	2.0E+06		3.1E+04		6.3E+00	
				5.0E-02	I					Butylate	2008-41-5					7.8E+02	6.0E+02		3.4E+02		3.3E-01	
2.0E-04	C	5.7E-08	C							Butylated hydroxyanisole	25013-16-5	3.4E+02	5.5E+02		2.1E+02						3.9E-01	
				5.0E-02	P			V		Butylbenzene, n-	104-51-8					7.8E+02			7.8E+02		2.5E+00	
				1.0E-01	X			V		Butylbenzene, sec-	135-98-8					1.6E+03			1.6E+03		4.6E+00	
				1.0E-01	X			V		Butylbenzene, tert-	98-06-6					1.6E+03	7.5E+02		5.1E+02		1.1E+00	
				1.0E+00	I					Butylphthalyl Butylglycolate	85-70-1					1.6E+04	2.9E+04		1.0E+04		2.3E+02	
				2.0E-02	A					Cacodylic Acid	75-60-5					3.1E+02	4.7E+04		3.1E+02			
		1.8E-03	I	1.0E-03	I	1.0E-05	A			Cadmium (Diet)	7440-43-9											
		1.8E-03	I	5.0E-04	I	1.0E-05	A			Cadmium (Water)	7440-43-9					7.8E+00	5.9E+01		6.9E+00	5.0E+00	5.2E-01	3.8E-01
				5.0E-01	I					Caprolactam	105-60-2					7.8E+03	6.4E+05		7.7E+03		1.9E+00	
1.5E-01	C	4.3E-05	C	2.0E-03	I					Captafol	2425-06-1	4.5E-01	1.5E+00		3.5E-01	3.1E+01	1.1E+02		2.4E+01		6.1E-04	
2.3E-03	C	6.6E-07	C	1.3E-01	I					Captan	133-06-2	2.9E+01	3.0E+02		2.7E+01	2.0E+03	2.1E+04		1.9E+03		1.9E-02	
				1.0E-01	I					Carbaryl	63-25-2					1.6E+03	1.7E+04		1.4E+03		1.3E+00	
				5.0E-03	I					Carbofuran	1563-66-2					7.8E+01	1.0E+03		7.3E+01	4.0E+01	2.8E-02	1.6E-02
				1.0E-01	I	7.0E-01	I	V		Carbon Disulfide	75-15-0					1.6E+03	1.3E+04	1.5E+03	7.2E+02		2.1E-01	
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		Carbon Tetrachloride	56-23-5	9.6E-01	3.7E+00	8.1E-01	3.9E-01	6.3E+01	2.4E+02	2.1E+02	4.0E+01	5.0E+00	1.5E-04	1.9E-03
				1.0E-02	I					Carbosulfan	55285-14-8					1.6E+02	4.9E+01		3.7E+01		9.0E-01	
				1.0E-01	I					Carboxin	5234-68-4					1.6E+03	2.9E+04		1.5E+03		8.0E-01	
						9.0E-04	I			Ceric oxide	1306-38-3											
				1.0E-01	I					Chloral Hydrate	302-17-0					1.6E+03	1.1E+05		1.5E+03		3.1E-01	
				1.5E-02	I					Chloramben	133-90-4					2.3E+02	5.2E+03		2.2E+02		5.5E-02	
4.0E-01	H									Chloranil	118-75-2	1.7E-01	3.0E+00		1.6E-01						1.3E-04	
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			Chlordane	12789-03-6	1.9E-01			1.9E-01	7.8E+00			7.8E+00	2.0E+00	1.3E-02	1.4E-01
1.0E+01	I	4.6E-03	C	3.0E-04	I					Chlordecone (Kepone)	143-50-0	6.7E-03	5.5E-03		3.0E-03	4.7E+00	3.8E+00		2.1E+00		1.1E-04	
				7.0E-04	A					Chlorfenvinphos	470-90-6					1.1E+01	4.0E+01		8.6E+00		2.3E-02	
				2.0E-02	I					Chlorimuron, Ethyl-	90982-32-4					3.1E+02	1.1E+04		3.0E+02		1.0E-01	
				1.0E-01	I	1.5E-04	A			Chlorine	7782-50-5					1.6E+03	2.4E+05		1.6E+03		7.0E-01	
				3.0E-02	I	2.0E-04	I			Chlorine Dioxide	10049-04-4					4.7E+02	7.1E+04		4.7E+02			
				3.0E-02	I					Chlorite (Sodium Salt)	7758-19-2					4.7E+02	7.1E+04		4.7E+02	1.0E+03		
						5.0E+01	I	V		Chloro-1,1-difluoroethane, 1-	75-68-3							1.0E+05	1.0E+05		5.2E+01	
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		Chloro-1,3-butadiene, 2-	126-99-8			1.6E-02	1.6E-02	3.1E+02	1.2E+03	4.2E+01	3.6E+01		8.5E-06	
4.6E-01	H									Chloro-2-methylaniline HCl, 4-	3165-93-3	1.5E-01	4.3E+02		1.5E-01						1.3E-04	
1.0E-01	P	7.7E-05	C	3.0E-03	X					Chloro-2-methylaniline, 4-	95-69-2	6.7E-01	5.6E+00		6.0E-01	4.7E+01	3.9E+02		4.2E+01		3.4E-04	
2.7E-01	X							V		Chloroacetaldehyde, 2-	107-20-0	2.5E-01	3.9E+01		2.5E-01						5.0E-05	
				2.0E-03	H					Chloroacetic Acid	79-11-8					3.1E+01	4.3E+03		3.1E+01	6.0E+01	6.3E-03	1.2E-02
						3.0E-05	I			Chloroacetophenone, 2-	532-27-4											
2.0E-01	P			4.0E-03	I					Chloroaniline, p-	106-47-8	3.4E-01	5.0E+00		3.2E-01	6.3E+01	9.4E+02		5.9E+01		1.3E-04	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-02	I	5.0E-02	P	V		Chlorobenzene	108-90-7					3.1E+02	9.1E+02	1.0E+02	7.2E+01	1.0E+02	4.9E-02	6.8E-02
1.1E-01	C	3.1E-05	C	2.0E-02	I					Chlorobenzilate	510-15-6	6.1E-01	4.8E-01		2.7E-01	3.1E+02	2.5E+02		1.4E+02		8.8E-04	
				3.0E-02	X					Chlorobenzoic Acid, p-	74-11-3					4.7E+02	2.4E+03		3.9E+02		9.9E-02	
				3.0E-03	P	3.0E-01	P	V		Chlorobenzotrifluoride, 4-	98-56-6					4.7E+01	6.6E+01	6.3E+02	2.6E+01		9.3E-02	
				4.0E-02	P			V		Chlorobutane, 1-	109-69-3					6.3E+02	2.1E+03		4.8E+02		2.0E-01	
						5.0E+01	I	V		Chlorodifluoromethane	75-45-6							1.0E+05	1.0E+05		4.3E+01	
				2.0E-02	P					Chloroethanol, 2-	107-07-3					3.1E+02	5.1E+04		3.1E+02		6.3E-02	
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		Chloroform	67-66-3	2.2E+00	2.5E+01	2.1E-01	1.9E-01	1.6E+02	1.8E+03	2.0E+02	8.4E+01	8.0E+01(F)	5.3E-05	2.2E-02
						9.0E-02	I	V		Chloromethane	74-87-3							1.9E+02	1.9E+02		4.9E-02	
2.4E+00	C	6.9E-04	C					V		Chloromethyl Methyl Ether	107-30-2	2.8E-02	3.1E+00	7.1E-03	5.6E-03						1.2E-06	
				8.0E-02	I			V		Chloronaphthalene, Beta-	91-58-7					1.3E+03	9.9E+02		5.5E+02		2.9E+00	
3.0E-01	P			3.0E-03	P	1.0E-05	X			Chloronitrobenzene, o-	88-73-3	2.2E-01	2.2E+00		2.0E-01	4.7E+01	4.6E+02		4.3E+01		1.9E-04	
6.3E-03	P			1.0E-03	P	6.0E-04	P			Chloronitrobenzene, p-	100-00-5	1.1E+01	8.2E+01		9.4E+00	1.6E+01	1.2E+02		1.4E+01		8.7E-03	
				5.0E-03	I			V		Chlorophenol, 2-	95-57-8					7.8E+01	7.2E+02		7.1E+01		5.7E-02	
						4.0E-04	C	V		Chloropicrin	76-06-2							8.3E-01	8.3E-01		2.5E-04	
3.1E-03	C	8.9E-07	C	1.5E-02	I					Chlorothalonil	1897-45-6	2.2E+01	1.4E+02		1.9E+01	2.3E+02	1.5E+03		2.0E+02		4.3E-02	
				2.0E-02	I			V		Chlorotoluene, o-	95-49-8					3.1E+02	4.1E+02		1.8E+02		1.7E-01	
				2.0E-02	X			V		Chlorotoluene, p-	106-43-4					3.1E+02	4.7E+02		1.9E+02		1.8E-01	
2.4E+02	C	6.9E-02	C							Chlorozotocin	54749-90-5	2.8E-04	6.3E-01		2.8E-04						6.2E-08	
				2.0E-01	I					Chlorpropham	101-21-3					3.1E+03	7.0E+03		2.2E+03		1.9E+00	
				1.0E-03	A					Chlorpyrifos	2921-88-2					1.6E+01	1.0E+01		6.2E+00		9.2E-02	
				1.0E-02	H					Chlorpyrifos Methyl	5598-13-0					1.6E+02	2.1E+02		8.9E+01		4.1E-01	
				5.0E-02	I					Chlorsulfuron	64902-72-3					7.8E+02	4.0E+04		7.7E+02		6.5E-01	
				8.0E-04	H					Chlorthiophos	60238-56-4					1.3E+01	2.4E+00		2.0E+00		5.2E-02	
				1.5E+00	I					Chromium(III), Insoluble Salts	16065-83-1					2.3E+04	4.6E+04		1.6E+04		2.8E+07	
5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I		M	Chromium(VI)	18540-29-9	4.3E-02	1.1E-01		3.1E-02	4.7E+01	8.9E+01		3.1E+01		5.9E-04	
										Chromium, Total	7440-47-3									1.0E+02		1.8E+05
		9.0E-03	P	3.0E-04	P	6.0E-06	P			Cobalt	7440-48-4					4.7E+00	1.8E+03		4.7E+00		2.1E-01	
		6.2E-04	I						M	Coke Oven Emissions	8007-45-2											
				4.0E-02	H					Copper	7440-50-8					6.3E+02	9.5E+04		6.2E+02	1.3E+03	2.2E+01	4.6E+01
				5.0E-02	I	6.0E-01	C			Cresol, m-	108-39-4					7.8E+02	8.5E+03		7.2E+02		5.7E-01	
				5.0E-02	I	6.0E-01	C			Cresol, o-	95-48-7					7.8E+02	8.6E+03		7.2E+02		5.8E-01	
				1.0E-01	A	6.0E-01	C			Cresol, p-	106-44-5					1.6E+03	1.7E+04		1.4E+03		1.1E+00	
				1.0E-01	A					Cresol, p-chloro-m-	59-50-7					1.6E+03	3.7E+03		1.1E+03		1.3E+00	
				1.0E-01	A	6.0E-01	C			Cresols	1319-77-3					1.6E+03	1.7E+04		1.4E+03		1.2E+00	
1.9E+00	H			1.0E-03	P			V		Crotonaldehyde, trans-	123-73-9	3.5E-02	2.3E+00		3.5E-02	1.6E+01	9.8E+02		1.5E+01		7.1E-06	
				1.0E-01	I	4.0E-01	I	V		Cumene	98-82-8					1.6E+03	1.4E+03	8.3E+02	3.9E+02		6.4E-01	
2.2E-01	C	6.3E-05	C							Cupferron	135-20-6	3.1E-01			3.1E-01						5.3E-04	
8.4E-01	H			2.0E-03	H					Cyanazine	21725-46-2	8.0E-02	1.4E+00		7.6E-02	3.1E+01	5.4E+02		3.0E+01		3.5E-05	
										Cyanides												
				1.0E-03	I					~Calcium Cyanide	592-01-8					1.6E+01	2.4E+03		1.6E+01			
				5.0E-03	I					~Copper Cyanide	544-92-3					7.8E+01	1.2E+04		7.8E+01			
				6.0E-04	I	8.0E-04	S	V		~Cyanide (CN-)	57-12-5					9.4E+00	1.4E+03	1.7E+00	1.4E+00	2.0E+02	1.4E-02	2.0E+00
				1.0E-03	I			V		~Cyanogen	460-19-5					1.6E+01	2.7E+03		1.6E+01			
				9.0E-02	I			V		~Cyanogen Bromide	506-68-3					1.4E+03	8.4E+05		1.4E+03			
				5.0E-02	I			V		~Cyanogen Chloride	506-77-4					7.8E+02	3.0E+05		7.8E+02			
				6.0E-04	I	8.0E-04	I	V		~Hydrogen Cyanide	74-90-8					9.4E+00	1.4E+03	1.7E+00	1.4E+00		1.4E-02	
				2.0E-03	I					~Potassium Cyanide	151-50-8					3.1E+01	2.4E+03		3.1E+01			
				5.0E-03	I					~Potassium Silver Cyanide	506-61-6					7.8E+01	2.4E+02		5.9E+01			
				1.0E-01	I					~Silver Cyanide	506-64-9					1.6E+03	9.5E+03		1.3E+03			
				1.0E-03	I					~Sodium Cyanide	143-33-9					1.6E+01	2.4E+03		1.6E+01	2.0E+02		
				2.0E-04	P					~Thiocyanates	NA					3.1E+00	4.7E+02		3.1E+00			
				2.0E-04	X					~Thiocyanic Acid	463-56-9					3.1E+00	4.7E+02		3.1E+00			
				5.0E-02	I					~Zinc Cyanide	557-21-1					7.8E+02	2.0E+05		7.8E+02			
						6.0E+00	I	V		Cyclohexane	110-82-7							1.3E+04	1.3E+04		1.3E+01	
2.3E-02	H									Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.9E+00	7.1E+00		2.1E+00						1.2E-02	
				5.0E+00	I	7.0E-01	P			Cyclohexanone	108-94-1					7.8E+04	4.5E+06		7.7E+04		1.8E+01	
				5.0E-03	P	1.0E+00	X	V		Cyclohexene	110-83-8					7.8E+01	1.8E+02	2.1E+03	5.3E+01		3.5E-02	
				2.0E-01	I					Cyclohexylamine	108-91-8					3.1E+03	6.4E+04		3.0E+03		7.9E-01	
				5.0E-03	I					Cyhalothrin/karate	68085-85-8					7.8E+01			7.8E+01		5.3E+01	
				1.0E-02	I					Cypermethrin	52315-07-8					1.6E+02			1.6E+02		2.5E+01	
				7.5E-03	I					Cyromazine	66215-27-8					1.2E+02	8.5E+03		1.2E+02		3.0E-02	
2.4E-01	I	6.9E-05	C							DDD	72-54-8	2.8E-01	3.0E-02		2.7E-02						6.4E-03	
3.4E-01	I	9.7E-05	C							DDE, p,p'-	72-55-9	2.0E-01			2.0E-01						4.6E-02	
3.4E-01	I	9.7E-05	I	5.0E-04	I					DDT	50-29-3	2.0E-01			2.0E-01	7.8E+00			7.8E+00		6.7E-02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information											Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.0E-02	I					Dacthal	1861-32-1					1.6E+02	2.3E+02		9.3E+01		1.1E-01	
				3.0E-02	I					Dalapon	75-99-0					4.7E+02	3.9E+04		4.6E+02	2.0E+02	9.6E-02	4.1E-02
7.0E-04	I			7.0E-03	I					Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	9.6E+01			9.6E+01	1.1E+02			1.1E+02		5.3E+01	
				4.0E-05	I					Demeton	8065-48-3					6.3E-01	2.9E+00		5.2E-01			
1.2E-03	I			6.0E-01	I					Di(2-ethylhexyl)adipate	103-23-1	5.6E+01			5.6E+01	9.4E+03			9.4E+03	4.0E+02	4.0E+00	2.9E+01
6.1E-02	H									Diallate	2303-16-4	1.1E+00	7.9E-01		4.6E-01						6.8E-04	
				7.0E-04	A					Diazinon	333-41-5					1.1E+01	2.8E+01		7.9E+00		4.9E-02	
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	Dibromo-3-chloropropane, 1,2-	96-12-8	2.7E-02	1.6E-01	3.2E-04	3.2E-04	3.1E+00	1.7E+01	4.2E-01	3.6E-01	2.0E-01	1.4E-07	8.6E-05
				1.0E-02	I					Dibromobenzene, 1,4-	106-37-6					1.6E+02	2.6E+02		9.8E+01		9.3E-02	
8.4E-02	I	2.7E-05	C	2.0E-02	I			V		Dibromochloromethane	124-48-1	8.0E-01	1.2E+01	1.8E-01	1.5E-01	3.1E+02	4.8E+03		2.9E+02	8.0E+01(F)	3.9E-05	2.1E-02
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		Dibromoethane, 1,2-	106-93-4	3.4E-02	6.1E-01	8.1E-03	6.5E-03	1.4E+02	2.5E+03	1.9E+01	1.6E+01	5.0E-02	1.8E-06	1.4E-05
				1.0E-02	H	4.0E-03	X	V		Dibromomethane (Methylene Bromide)	74-95-3					1.6E+02	3.9E+03	8.3E+00	7.9E+00		1.9E-03	
				1.0E-01	I					Dibutyl Phthalate	84-74-2					1.6E+03	1.2E+03		6.7E+02		1.7E+00	
				3.0E-04	P					Dibutyltin Compounds	NA					4.7E+00			4.7E+00			
				3.0E-02	I					Dicamba	1918-00-9					4.7E+02	7.2E+03		4.4E+02		1.1E-01	
		4.2E-03	P					V		Dichloro-2-butene, 1,4-	764-41-0			1.2E-03	1.2E-03						5.4E-07	
		4.2E-03	P					V		Dichloro-2-butene, cis-1,4-	1476-11-5			1.2E-03	1.2E-03						5.4E-07	
		4.2E-03	P					V		Dichloro-2-butene, trans-1,4-	110-57-6			1.2E-03	1.2E-03						5.4E-07	
5.0E-02	I			4.0E-03	I					Dichloroacetic Acid	79-43-6	1.3E+00	8.2E+01		1.3E+00	6.3E+01	3.8E+03		6.2E+01	6.0E+01	2.7E-04	1.2E-02
				9.0E-02	I	2.0E-01	H	V		Dichlorobenzene, 1,2-	95-50-1					1.4E+03	2.1E+03	4.2E+02	2.8E+02	6.0E+02	2.7E-01	5.8E-01
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		Dichlorobenzene, 1,4-	106-46-7	1.2E+01	1.8E+01	4.4E-01	4.2E-01	1.1E+03	1.6E+03	1.7E+03	4.7E+02	7.5E+01	4.0E-04	7.2E-02
4.5E-01	I	3.4E-04	C							Dichlorobenzidine, 3,3'-	91-94-1	1.5E-01	3.9E-01		1.1E-01						7.1E-04	
				9.0E-03	X					Dichlorobenzophenone, 4,4'-	90-98-2					1.4E+02	9.7E+01		5.7E+01		3.5E-01	
				2.0E-01	I	1.0E-01	X	V		Dichlorodifluoromethane	75-71-8					3.1E+03	2.7E+04	2.1E+02	1.9E+02		3.0E-01	
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		Dichloroethane, 1,1-	75-34-3	1.2E+01	1.6E+02	3.0E+00	2.4E+00	3.1E+03	4.0E+04		2.9E+03		6.8E-04	
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		Dichloroethane, 1,2-	107-06-2	7.4E-01	1.6E+01	1.9E-01	1.5E-01	9.4E+01	1.9E+03	1.5E+01	1.3E+01	5.0E+00	4.2E-05	1.4E-03
				5.0E-02	I	2.0E-01	I	V		Dichloroethylene, 1,1-	75-35-4					7.8E+02	5.9E+03	4.2E+02	2.6E+02	7.0E+00	9.3E-02	2.5E-03
				9.0E-03	H			V		Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0					1.4E+02	1.1E+03		1.3E+02		3.7E-02	
				2.0E-03	I			V		Dichloroethylene, 1,2-cis-	156-59-2					3.1E+01	2.5E+02		2.8E+01	7.0E+01	8.2E-03	2.1E-02
				2.0E-02	I	6.0E-02	P	V		Dichloroethylene, 1,2-trans-	156-60-5					3.1E+02	2.5E+03	1.3E+02	8.6E+01	1.0E+02	2.5E-02	2.9E-02
				3.0E-03	I					Dichlorophenol, 2,4-	120-83-2					4.7E+01	1.3E+02		3.5E+01		4.1E-02	
				1.0E-02	I					Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					1.6E+02	9.6E+02		1.3E+02	7.0E+01	3.5E-02	1.8E-02
				8.0E-03	I					Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6					1.3E+02	3.4E+02		9.1E+01		3.6E-02	
3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		Dichloropropane, 1,2-	78-87-5	1.9E+00	2.0E+01	4.9E-01	3.8E-01	1.4E+03	1.5E+04	8.3E+00	8.3E+00	5.0E+00	1.3E-04	1.7E-03
				2.0E-02	P			V		Dichloropropane, 1,3-	142-28-9					3.1E+02	3.3E+03		2.9E+02		9.9E-02	
				3.0E-03	I					Dichloropropanol, 2,3-	616-23-9					4.7E+01	3.5E+03		4.6E+01		9.8E-03	
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		Dichloropropene, 1,3-	542-75-6	6.7E-01	6.7E+00	1.2E+00	4.1E-01	4.7E+02	4.7E+03	4.2E+01	3.8E+01		1.5E-04	
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			Dichlorvos	62-73-7	2.3E-01	1.2E+01		2.3E-01	7.8E+00	4.0E+02		7.7E+00		7.0E-05	
				8.0E-03	P	7.0E-03	P	V		Dicyclopentadiene	77-73-6					1.3E+02	2.5E+02	1.5E+01	1.2E+01		4.3E-02	
1.6E+01	I	4.6E-03	I	5.0E-05	I					Dieldrin	60-57-1	4.2E-03	2.3E-03		1.5E-03	7.8E-01	4.3E-01		2.8E-01		6.1E-05	
		3.0E-04	C			5.0E-03	I			Diesel Engine Exhaust	NA											
				2.0E-03	P	2.0E-04	P			Diethanolamine	111-42-2					3.1E+01	5.8E+04		3.1E+01		6.3E-03	
				8.0E-01	I					Diethyl Phthalate	84-66-2					1.3E+04	1.4E+05		1.1E+04		4.7E+00	
				3.0E-02	P	1.0E-04	P			Diethylene Glycol Monobutyl Ether	112-34-5					4.7E+02	6.1E+04		4.7E+02		1.0E-01	
				6.0E-02	P	3.0E-04	P			Diethylene Glycol Monoethyl Ether	111-90-0					9.4E+02	5.5E+05		9.4E+02		1.9E-01	
				1.0E-03	P					Diethylformamide	617-84-5					1.6E+01	2.9E+03		1.6E+01		3.2E-03	
3.5E+02	C	1.0E-01	C							Diethylstilbestrol	56-53-1	1.9E-04	5.6E-05		4.3E-05						2.4E-05	
				8.0E-02	I					Difenzoquat	43222-48-6					1.3E+03	5.2E+05		1.2E+03			
				2.0E-02	I					Diflubenzuron	35367-38-5					3.1E+02	7.4E+02		2.2E+02		2.5E-01	
						4.0E+01	I	V		Difluoroethane, 1,1-	75-37-6							8.3E+04	8.3E+04		2.8E+01	
4.4E-02	C	1.3E-05	C					V		Dihydrosafrole	94-58-6	1.5E+00	2.0E+00	3.7E-01	2.6E-01						3.2E-04	
						7.0E-01	P	V		Diisopropyl Ether	108-20-3							1.5E+03	1.5E+03		3.7E-01	
				8.0E-02	I			V		Diisopropyl Methylphosphonate	1445-75-6					1.3E+03	9.0E+04		1.2E+03		3.5E-01	
				2.0E-02	I					Dimethipin	55290-64-7					3.1E+02	1.7E+05		3.1E+02		6.9E-02	
				2.0E-04	I					Dimethoate	60-51-5					3.1E+00	4.5E+02		3.1E+00		7.0E-04	
1.4E-02	H									Dimethoxybenzidine, 3,3'-	119-90-4	4.8E+00	1.6E+02		4.7E+00						5.7E-03	
1.7E-03	P			6.0E-02	P					Dimethyl methylphosphonate	756-79-6	4.0E+01	2.4E+04		3.9E+01	9.4E+02	5.7E+05		9.4E+02		8.3E-03	
4.6E+00	C	1.3E-03	C							Dimethylamino azobenzene [p-]	60-11-7	1.5E-02	6.1E-03		4.3E-03						1.8E-05	
5.8E-01	H									Dimethylaniline HCl, 2,4-	21436-96-4	1.2E-01	3.5E+02		1.2E-01						1.0E-04	
2.0E-01	P			2.0E-03	X					Dimethylaniline, 2,4-	95-68-1	3.4E-01	6.1E+00		3.2E-01	3.1E+01	5.7E+02		3.0E+01		1.8E-04	
				2.0E-03	I			V		Dimethylaniline, N,N-	121-69-7					3.1E+01	2.2E+02		2.7E+01		9.8E-03	
1.1E+01	P									Dimethylbenzidine, 3,3'-	119-93-7	6.1E-03	7.2E-02		5.6E-03						3.7E-05	
				1.0E-01	P	3.0E-02	I			Dimethylformamide	68-12-2					1.6E+03	1.2E+06		1.6E+03		3.2E-01	
				1.0E-04	X	2.0E-06	X			Dimethylhydrazine, 1,1-	57-14-7					1.6E+00	2.2E+03		1.6E+00		3.5E-04	
5.5E+02	C	1.6E-01	C							Dimethylhydrazine, 1,2-	540-73-8	1.2E-04	4.2E-02		1.2E-04						2.8E-08	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-02	I					Dimethylphenol, 2,4-	105-67-9					3.1E+02	2.2E+03		2.7E+02		3.2E-01	
				6.0E-04	I					Dimethylphenol, 2,6-	576-26-1					9.4E+00	6.0E+01		8.1E+00		9.8E-03	
				1.0E-03	I					Dimethylphenol, 3,4-	95-65-8					1.6E+01	1.2E+02		1.4E+01		1.6E-02	
				1.0E-01	I			V		Dimethylterephthalate	120-61-6					1.6E+03	1.9E+04		1.4E+03		3.8E-01	
4.5E-02	C	1.3E-05	C					V		Dimethylvinylchloride	513-37-1	1.5E+00	5.6E+00	3.7E-01	2.8E-01						1.8E-04	
				8.0E-05	X					Dinitro-o-cresol, 4,6-	534-52-1					1.3E+00	1.9E+01		1.2E+00		2.0E-03	
				2.0E-03	I					Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					3.1E+01	3.8E+01		1.7E+01		5.7E-01	
				1.0E-04	P					Dinitrobenzene, 1,2-	528-29-0					1.6E+00	3.8E+01		1.5E+00		1.4E-03	
				1.0E-04	I					Dinitrobenzene, 1,3-	99-65-0					1.6E+00	5.1E+01		1.5E+00		1.4E-03	
				1.0E-04	P					Dinitrobenzene, 1,4-	100-25-4					1.6E+00	5.4E+01		1.5E+00		1.4E-03	
				2.0E-03	I					Dinitrophenol, 2,4-	51-28-5					3.1E+01	8.6E+02		3.0E+01		3.4E-02	
6.8E-01	I									Dinitrotoluene Mixture, 2,4/2,6-	NA	9.9E-02	1.2E+00		9.2E-02						1.3E-04	
3.1E-01	C	8.9E-05	C	2.0E-03	I					Dinitrotoluene, 2,4-	121-14-2	2.2E-01	3.7E+00		2.0E-01	3.1E+01	5.3E+02		3.0E+01		2.8E-04	
1.5E+00	P			3.0E-04	X					Dinitrotoluene, 2,6-	606-20-2	4.5E-02	6.3E-01		4.2E-02	4.7E+00	6.6E+01		4.4E+00		5.8E-05	
				2.0E-03	S					Dinitrotoluene, 2-Amino-4,6-	35572-78-2					3.1E+01	7.3E+02		3.0E+01		2.3E-02	
				2.0E-03	S					Dinitrotoluene, 4-Amino-2,6-	19406-51-0					3.1E+01	7.3E+02		3.0E+01		2.3E-02	
4.5E-01	X			9.0E-04	X					Dinitrotoluene, Technical grade	25321-14-6	1.5E-01	1.9E+00		1.4E-01	1.4E+01	1.8E+02		1.3E+01		1.9E-04	
				1.0E-03	I					Dinoseb	88-85-7					1.6E+01	3.8E+01		1.1E+01	7.0E+00	9.8E-02	6.2E-02
1.0E-01	I	7.7E-06	C	3.0E-02	I	1.1E-01	A			Dioxane, 1,4-	123-91-1	6.7E-01	1.9E+02		6.7E-01	4.7E+02	1.3E+05		4.7E+02		1.4E-04	
										Dioxins												
6.2E+03	I	1.3E+00	I							~Hexachlorodibenzo-p-dioxin, Mixture	NA	1.1E-05			1.1E-05						1.5E-05	
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C			~TCDD, 2,3,7,8-	1746-01-6	5.2E-07			5.2E-07	1.1E-05			1.1E-05	3.0E-05	2.6E-07	1.5E-05
				3.0E-02	I					Diphenamid	957-51-7					4.7E+02	3.0E+03		4.1E+02		4.0E+00	
				8.0E-04	X					Diphenyl Sulfone	127-63-9					1.3E+01	1.4E+02		1.1E+01		2.8E-02	
				2.5E-02	I					Diphenylamine	122-39-4					3.9E+02	6.0E+02		2.4E+02		4.4E-01	
8.0E-01	I	2.2E-04	I							Diphenylhydrazine, 1,2-	122-66-7	8.4E-02	3.3E-01		6.7E-02						2.2E-04	
				2.2E-03	I					Diquat	85-00-7					3.4E+01			3.4E+01	2.0E+01	6.5E-01	3.7E-01
7.4E+00	C	2.1E-03	C							Direct Black 38	1937-37-7	9.1E-03			9.1E-03						4.4E+00	
7.4E+00	C	2.1E-03	C							Direct Blue 6	2602-46-2	9.1E-03			9.1E-03						1.4E+01	
6.7E+00	C	1.9E-03	C							Direct Brown 95	16071-86-6	1.0E-02			1.0E-02							
				4.0E-05	I					Disulfoton	298-04-4					6.3E-01	9.5E-01		3.8E-01		7.1E-04	
				1.0E-02	I			V		Dithiane, 1,4-	505-29-3					1.6E+02	1.1E+04		1.5E+02		7.6E-02	
				2.0E-03	I					Diuron	330-54-1					3.1E+01	2.5E+02		2.8E+01		1.2E-02	
				4.0E-03	I					Dodine	2439-10-3					6.3E+01	7.5E+03		6.2E+01		3.2E-01	
				2.5E-02	I			V		EPTC	759-94-4					3.9E+02	1.1E+03		2.9E+02		1.5E-01	
				6.0E-03	I					Endosulfan	115-29-7					9.4E+01	4.5E+02		7.8E+01		1.1E+00	
				2.0E-02	I					Endothall	145-73-3					3.1E+02	6.1E+03		3.0E+02	1.0E+02	7.1E-02	2.4E-02
				3.0E-04	I					Endrin	72-20-8					4.7E+00	2.6E+00		1.7E+00	2.0E+00	6.8E-02	8.1E-02
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		Epichlorohydrin	106-89-8	6.8E+00	6.7E+02	4.1E+00	2.5E+00	9.4E+01	8.9E+03	2.1E+00	2.0E+00		4.5E-04	
						2.0E-02	I	V		Epoxybutane, 1,2-	106-88-7							4.2E+01	4.2E+01		9.2E-03	
				5.0E-03	I					Ethephon	16672-87-0					7.8E+01	3.0E+04		7.8E+01		1.6E-02	
				5.0E-04	I					Ethion	563-12-2					7.8E+00	5.4E+00		3.2E+00		6.3E-03	
				1.0E-01	P	6.0E-02	P			Ethoxyethanol Acetate, 2-	111-15-9					1.6E+03	1.6E+05		1.5E+03		3.2E-01	
				4.0E-01	H	2.0E-01	I			Ethoxyethanol, 2-	110-80-5					6.3E+03	1.9E+06		6.2E+03		1.3E+00	
				9.0E-01	I			V		Ethyl Acetate	141-78-6					1.4E+04	8.4E+05		1.4E+04		2.9E+00	
4.8E-02	H							V		Ethyl Acrylate	140-88-5	1.4E+00	3.8E+01		1.4E+00						3.0E-04	
						1.0E+01	I	V		Ethyl Chloride	75-00-3							2.1E+04	2.1E+04		5.9E+00	
				2.0E-01	I			V		Ethyl Ether	60-29-7					3.1E+03	1.3E+05		3.1E+03		6.8E-01	
				9.0E-02	H	3.0E-01	P	V		Ethyl Methacrylate	97-63-2					1.4E+03	1.6E+04	6.3E+02	4.2E+02		9.9E-02	
				1.0E-05	I					Ethyl-p-nitrophenyl Phosphonate	2104-64-5					1.6E-01	1.1E-01		6.6E-02		2.1E-03	
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		Ethylbenzene	100-41-4	6.1E+00	1.1E+01	1.9E+00	1.3E+00	1.6E+03	2.6E+03	2.1E+03	6.7E+02	7.0E+02	1.5E-03	7.8E-01
				7.0E-02	P					Ethylene Cyanohydrin	109-78-4					1.1E+03	7.3E+05		1.1E+03		2.2E-01	
				9.0E-02	P					Ethylene Diamine	107-15-3					1.4E+03			1.4E+03		3.2E-01	
				2.0E+00	I	4.0E-01	C			Ethylene Glycol	107-21-1					3.1E+04	3.7E+07		3.1E+04		6.3E+00	
				1.0E-01	I	1.6E+00	I			Ethylene Glycol Monobutyl Ether	111-76-2					1.6E+03	1.0E+05		1.5E+03		3.2E-01	
3.1E-01	C	8.8E-05	C			3.0E-02	C	V		Ethylene Oxide	75-21-8	2.2E-01	4.6E+01	5.5E-02	4.4E-02			6.3E+01	6.3E+01		9.1E-06	
4.5E-02	C	1.3E-05	C	8.0E-05	I					Ethylene Thiourea	96-45-7	1.5E+00	8.6E+02		1.5E+00	1.3E+00	7.0E+02		1.2E+00		2.8E-04	
6.5E+01	C	1.9E-02	C					V		Ethyleneimine	151-56-4	1.0E-03	2.1E-01	2.6E-04	2.1E-04						4.5E-08	
				3.0E+00	I					Ethylphthalyl Ethyl Glycolate	84-72-0					4.7E+04	1.1E+06		4.5E+04		1.0E+02	
				8.0E-03	I					Express	101200-48-0					1.3E+02	3.5E+03		1.2E+02		4.7E-02	
				2.5E-04	I					Fenamiphos	22224-92-6					3.9E+00	2.4E+01		3.4E+00		3.3E-03	
				2.5E-02	I					Fenpropathrin	39515-41-8					3.9E+02	5.2E+01		4.6E+01		2.1E+00	
				1.3E-02	I					Fluometuron	2164-17-2					2.0E+02	2.4E+03		1.9E+02		1.4E-01	
				4.0E-02	C	1.3E-02	C			Fluoride	16984-48-8					6.3E+02	9.5E+04		6.2E+02		9.3E+01	
				6.0E-02	I	1.3E-02	C			Fluorine (Soluble Fluoride)	7782-41-4					9.4E+02	1.4E+05		9.3E+02	4.0E+03	1.4E+02	6.0E+02

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				8.0E-02	I					Fluridone	59756-60-4					1.3E+03	1.0E+04		1.1E+03		1.3E+02	
				2.0E-02	I					Flurprimidol	56425-91-3					3.1E+02	1.7E+03		2.6E+02		1.2E+00	
				6.0E-02	I					Flutolanil	66332-96-5					9.4E+02	3.2E+03		7.2E+02		3.9E+00	
				1.0E-02	I					Fluvalinate	69409-94-5					1.6E+02			1.6E+02		2.3E+02	
3.5E-03	I			1.0E-01	I					Folpet	133-07-3	1.9E+01	1.8E+02		1.7E+01	1.6E+03	1.5E+04		1.4E+03		4.1E-03	
1.9E-01	I									Fomesafen	72178-02-0	3.5E-01	7.7E+00		3.4E-01						1.1E-03	
				2.0E-03	I					Fonofos	944-22-9					3.1E+01	4.4E+01		1.8E+01		3.5E-02	
		1.3E-05	I	2.0E-01	I	9.8E-03	A			Formaldehyde	50-00-0					3.1E+03	2.0E+05		3.1E+03		6.2E-01	
				9.0E-01	P	3.0E-04	X			Formic Acid	64-18-6					1.4E+04	4.1E+06		1.4E+04		2.8E+00	
				3.0E+00	I					Fosetyl-AL	39148-24-8					4.7E+04			4.7E+04			
										Furans												
				1.0E-03	X				V	~Dibenzofuran	132-64-9					1.6E+01	9.2E+00		5.8E+00		1.1E-01	
				1.0E-03	I				V	~Furan	110-00-9					1.6E+01	3.1E+02		1.5E+01		5.7E-03	
				9.0E-01	I	2.0E+00	I	V		~Tetrahydrofuran	109-99-9					1.4E+04	1.1E+06	4.2E+03	3.2E+03		7.1E-01	
3.8E+00	H									Furazolidone	67-45-8	1.8E-02	8.7E+00		1.8E-02						3.4E-05	
				3.0E-03	I	5.0E-02	H			Furfural	98-01-1					4.7E+01	4.9E+03		4.6E+01		9.9E-03	
1.5E+00	C	4.3E-04	C							Furium	531-82-8	4.5E-02	1.6E+00		4.4E-02						5.9E-05	
3.0E-02	I	8.6E-06	C							Furmecyclox	60568-05-0	2.2E+00	1.7E+00		9.6E-01						1.0E-03	
				4.0E-04	I					Glufosinate, Ammonium	77182-82-2					6.3E+00			6.3E+00		1.4E-03	
						8.0E-05	C			Glutaraldehyde	111-30-8											
				4.0E-04	I	1.0E-03	H			Glycidyl	765-34-4					6.3E+00	1.2E+03		6.2E+00		1.3E-03	
				1.0E-01	I					Glyphosate	1071-83-6					1.6E+03			1.6E+03	7.0E+02	6.9E+00	3.1E+00
				3.0E-03	I					Goal	42874-03-3					4.7E+01	4.7E+01		2.4E+01		1.9E+00	
				3.0E-03	A	1.0E-02	A			Guthion	86-50-0					4.7E+01	5.9E+02		4.3E+01		1.3E-02	
				5.0E-05	I					Haloxyfop, Methyl	69806-40-2					7.8E-01	2.2E+00		5.8E-01		6.4E-03	
				1.3E-02	I					Harmony	79277-27-3					2.0E+02	2.5E+04		2.0E+02		6.1E-02	
4.5E+00	I	1.3E-03	I	5.0E-04	I					Heptachlor	76-44-8	1.5E-02	2.0E-03		1.8E-03	7.8E+00	1.0E+00		9.2E-01	4.0E-01	1.4E-04	3.3E-02
9.1E+00	I	2.6E-03	I	1.3E-05	I					Heptachlor Epoxide	1024-57-3	7.4E-03	6.1E-03		3.3E-03	2.0E-01	1.7E-01		9.2E-02	2.0E-01	6.8E-05	4.1E-03
				2.0E-03	I					Hexabromobenzene	87-82-1					3.1E+01			3.1E+01		1.8E-01	
				2.0E-04	I					Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					3.1E+00			3.1E+00			
1.6E+00	I	4.6E-04	I	8.0E-04	I					Hexachlorobenzene	118-74-1	4.2E-02			4.2E-02	1.3E+01			1.3E+01	1.0E+00	5.3E-04	1.3E-02
7.8E-02	I	2.2E-05	I	1.0E-03	P					Hexachlorobutadiene	87-68-3	8.6E-01	3.7E-01		2.6E-01	1.6E+01	6.8E+00		4.7E+00		5.0E-04	
6.3E+00	I	1.8E-03	I	8.0E-03	A					Hexachlorocyclohexane, Alpha-	319-84-6	1.1E-02	1.5E-02		6.2E-03	1.3E+02	1.7E+02		7.3E+01		3.6E-05	
1.8E+00	I	5.3E-04	I							Hexachlorocyclohexane, Beta-	319-85-7	3.7E-02	5.2E-02		2.2E-02						1.3E-04	
1.1E+00	C	3.1E-04	C	3.0E-04	I					Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	6.1E-02	8.5E-02		3.6E-02	4.7E+00	6.6E+00		2.7E+00	2.0E-01	2.1E-04	1.2E-03
1.8E+00	I	5.1E-04	I							Hexachlorocyclohexane, Technical	608-73-1	3.7E-02	5.2E-02		2.2E-02						1.3E-04	
				6.0E-03	I	2.0E-04	I			Hexachlorocyclopentadiene	77-47-4					9.4E+01	2.9E+01		2.2E+01	5.0E+01	7.0E-02	1.6E-01
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I			Hexachloroethane	67-72-1	1.7E+00	1.5E+00		7.9E-01	1.1E+01	9.7E+00		5.1E+00		4.8E-04	
				3.0E-04	I					Hexachlorophene	70-30-4					4.7E+00			4.7E+00		6.3E+00	
1.1E-01	I			3.0E-03	I					Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	6.1E-01	7.3E+01		6.1E-01	4.7E+01	5.6E+03		4.7E+01		2.3E-04	
						1.0E-05	I	V		Hexamethylene Diisocyanate, 1,6-	822-06-0							2.1E-02	2.1E-02		2.1E-04	
				4.0E-04	P					Hexamethylphosphoramide	680-31-9					6.3E+00	1.4E+03		6.2E+00		1.4E-03	
				6.0E-02	H	7.0E-01	I	V		Hexane, N-	110-54-3					9.4E+02	4.5E+02	1.5E+03	2.5E+02		1.8E+00	
				2.0E+00	P					Hexanedioic Acid	124-04-9					3.1E+04	7.7E+06		3.1E+04		7.7E+00	
				5.0E-03	I	3.0E-02	I	V		Hexanone, 2-	591-78-6					7.8E+01	1.9E+03	6.3E+01	3.4E+01		7.9E-03	
				3.3E-02	I					Hexazinone	51235-04-2					5.2E+02	1.7E+04		5.0E+02		2.3E-01	
3.0E+00	I	4.9E-03	I			3.0E-05	P			Hydrazine	302-01-2	2.2E-02	9.5E+01		2.2E-02							
3.0E+00	I	4.9E-03	I							Hydrazine Sulfate	10034-93-2	2.2E-02	4.2E+00		2.2E-02							
						2.0E-02	I			Hydrogen Chloride	7647-01-0											
				4.0E-02	C	1.4E-02	C			Hydrogen Fluoride	7664-39-3					6.3E+02	9.5E+04		6.2E+02			
						2.0E-03	I			Hydrogen Sulfide	7783-06-4											
6.0E-02	P			4.0E-02	P					Hydroquinone	123-31-9	1.1E+00	1.0E+02		1.1E+00	6.3E+02	5.6E+04		6.2E+02		7.5E-04	
				1.3E-02	I					Imazalil	35554-44-0					2.0E+02	4.8E+02		1.4E+02		2.5E+00	
				2.5E-01	I					Imazaquin	81335-37-7					3.9E+03	1.8E+05		3.8E+03		1.9E+01	
				1.0E-02	A					Iodine	7553-56-2					1.6E+02	2.4E+04		1.6E+02		9.4E+00	
				4.0E-02	I					Iprodione	36734-19-7					6.3E+02	6.4E+03		5.7E+02		1.7E-01	
				7.0E-01	P					Iron	7439-89-6					1.1E+04	1.7E+06		1.1E+04		2.7E+02	
				3.0E-01	I					Isobutyl Alcohol	78-83-1					4.7E+03	2.4E+05		4.6E+03		9.5E-01	
9.5E-04	I			2.0E-01	I	2.0E+00	C			Isophorone	78-59-1	7.1E+01	1.4E+03		6.7E+01	3.1E+03	6.1E+04		3.0E+03		2.2E-02	
				1.5E-02	I					Isopropalin	33820-53-0					2.3E+02	3.3E+01		2.9E+01		6.6E-01	
						7.0E+00	C			Isopropanol	67-63-0											
				1.0E-01	I					Isopropyl Methyl Phosphonic Acid	1832-54-8					1.6E+03	2.7E+05		1.6E+03		3.4E-01	
				5.0E-02	I					Isoxaben	82558-50-7					7.8E+02	1.9E+03		5.6E+02		1.5E+00	
						3.0E-01	A	V		JP-7	NA							6.3E+02	6.3E+02			
				7.5E-02	I					Kerb	23950-58-5					1.2E+03	3.9E+03		9.0E+02		9.1E-01	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				2.0E-03	I					Lactofen	77501-63-4					3.1E+01	4.7E+01		1.9E+01		8.7E-01	
										Lead Compounds												
2.8E-01	C	8.0E-05	C							~Lead acetate	301-04-2	2.4E-01	2.4E+02		2.4E-01							
										~Lead and Compounds	7439-92-1									1.5E+01		1.4E+01
3.8E-02	C	1.1E-05	C							~Lead subacetate	1335-32-6	1.8E+00			1.8E+00							
				1.0E-07	I					~Tetraethyl Lead	78-00-2					1.6E-03	2.7E-03		9.9E-04		3.5E-06	
				2.0E-03	I					Linuron	330-55-2					3.1E+01	1.4E+02		2.6E+01		2.3E-02	
				2.0E-03	P					Lithium	7439-93-2					3.1E+01	4.7E+03		3.1E+01		9.3E+00	
				2.0E-01	I					Londax	83055-99-6					3.1E+03	1.7E+05		3.1E+03		7.9E-01	
				5.0E-04	I					MCPA	94-74-6					7.8E+00	2.1E+01		5.7E+00		1.5E-03	
				1.0E-02	I					MCPB	94-81-5					1.6E+02	3.9E+02		1.1E+02		4.4E-02	
				1.0E-03	I					MCPP	93-65-2					1.6E+01	5.1E+01		1.2E+01		3.5E-03	
				2.0E-02	I					Malathion	121-75-5					3.1E+02	7.7E+03		3.0E+02		7.9E-02	
				1.0E-01	I	7.0E-04	C			Maleic Anhydride	108-31-6					1.6E+03	2.6E+04		1.5E+03		3.0E-01	
				5.0E-01	I					Maleic Hydrazide	123-33-1					7.8E+03	6.3E+06		7.8E+03		1.6E+00	
				1.0E-04	P					Malononitrile	109-77-3					1.6E+00	6.0E+02		1.6E+00		3.2E-04	
				3.0E-02	H					Mancozeb	8018-01-7					4.7E+02	2.6E+04		4.6E+02		6.5E-01	
				5.0E-03	I					Maneb	12427-38-2					7.8E+01	4.4E+03		7.7E+01		1.1E-01	
				1.4E-01	I	5.0E-05	I			Manganese (Diet)	7439-96-5											
				2.4E-02	S	5.0E-05	I			Manganese (Non-diet)	7439-96-5					3.8E+02	2.3E+03		3.2E+02		2.1E+01	
				9.0E-05	H					Mephosfolan	950-10-7					1.4E+00	1.8E+02		1.4E+00		2.1E-03	
				3.0E-02	I					Mepiquat Chloride	24307-26-4					4.7E+02			4.7E+02		1.6E-01	
										Mercury Compounds												
				3.0E-04	I	3.0E-04	S			~Mercuric Chloride (and other Mercury salts)	7487-94-7					4.7E+00	5.0E+01		4.3E+00	2.0E+00		
						3.0E-04	I	V		~Mercury (elemental)	7439-97-6							6.3E-01	6.3E-01	2.0E+00	3.3E-02	1.0E-01
				1.0E-04	I					~Methyl Mercury	22967-92-6					1.6E+00	2.4E+02		1.6E+00			
				8.0E-05	I					~Phenylmercuric Acetate	62-38-4					1.3E+00	4.0E+02		1.2E+00		3.9E-04	
				3.0E-05	I					Merphos	150-50-5					4.7E-01			4.7E-01		4.6E-02	
				3.0E-05	I					Merphos Oxide	78-48-8					4.7E-01	7.0E-02		6.1E-02		3.0E-04	
				6.0E-02	I					Metalaxyl	57837-19-1					9.4E+02	4.5E+04		9.2E+02		2.5E-01	
				1.0E-04	I	3.0E-02	P	V		Methacrylonitrile	126-98-7					1.6E+00	8.5E+01	6.3E+01	1.5E+00		3.4E-04	
				5.0E-05	I					Methamidophos	10265-92-6					7.8E-01	7.2E+02		7.8E-01		1.6E-04	
				5.0E-01	I	4.0E+00	C			Methanol	67-56-1					7.8E+03	2.8E+06		7.8E+03		1.6E+00	
				1.0E-03	I					Methidathion	950-37-8					1.6E+01	4.1E+02		1.5E+01		3.7E-03	
				2.5E-02	I					Methomyl	16752-77-5					3.9E+02	4.8E+04		3.9E+02		8.5E-02	
4.9E-02	C	1.4E-05	C							Methoxy-5-nitroaniline, 2-	99-59-2	1.4E+00	4.6E+01		1.3E+00						4.6E-04	
				5.0E-03	I					Methoxychlor	72-43-5					7.8E+01	4.2E+01		2.7E+01	4.0E+01	1.5E+00	2.2E+00
				8.0E-03	P	1.0E-03	P			Methoxyethanol Acetate, 2-	110-49-6					1.3E+02	2.5E+04		1.2E+02		2.6E-02	
				5.0E-03	P	2.0E-02	I			Methoxyethanol, 2-	109-86-4					7.8E+01	4.2E+04		7.8E+01		1.6E-02	
				1.0E+00	X			V		Methyl Acetate	79-20-9					1.6E+04	1.9E+06		1.6E+04		3.2E+00	
				3.0E-02	H	2.0E-02	P	V		Methyl Acrylate	96-33-3					4.7E+02	2.5E+04	4.2E+01	3.8E+01		8.1E-03	
				6.0E-01	I	5.0E+00	I	V		Methyl Ethyl Ketone (2-Butanone)	78-93-3					9.4E+03	9.7E+05	1.0E+04	4.9E+03		1.0E+00	
		1.0E-03	X	1.0E-03	P	2.0E-05	X			Methyl Hydrazine	60-34-4					1.6E+01	9.9E+03		1.6E+01		3.5E-03	
				8.0E-02	H	3.0E+00	I	V		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1					1.3E+03	3.4E+04	6.3E+03	1.0E+03		2.3E-01	
						1.0E-03	C	V		Methyl Isocyanate	624-83-9							2.1E+00	2.1E+00		5.9E-04	
				1.4E+00	I	7.0E-01	I	V		Methyl Methacrylate	80-62-6					2.2E+04	5.3E+05	1.5E+03	1.4E+03		3.0E-01	
				2.5E-04	I					Methyl Parathion	298-00-0					3.9E+00	2.9E+01		3.4E+00		5.7E-03	
				6.0E-02	X					Methyl Phosphonic Acid	993-13-5					9.4E+02	8.4E+05		9.4E+02		1.9E-01	
				6.0E-03	H	4.0E-02	H	V		Methyl Styrene (Mixed Isomers)	25013-15-4					9.4E+01	1.1E+02	8.3E+01	3.2E+01		5.2E-02	
9.9E-02	C	2.8E-05	C							Methyl methanesulfonate	66-27-3	6.8E-01	4.1E+02		6.8E-01						1.4E-04	
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.7E+01	1.7E+03	1.9E+01	1.2E+01			6.3E+03	6.3E+03		2.8E-03	
				3.0E-04	X					Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					4.7E+00	4.2E+04		4.7E+00		2.8E-03	
9.0E-03	P			2.0E-02	X					Methyl-5-Nitroaniline, 2-	99-55-8	7.5E+00	1.2E+02		7.0E+00	3.1E+02	5.2E+03		2.9E+02		3.9E-03	
8.3E+00	C	2.4E-03	C							Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	8.1E-03	9.3E+00		8.1E-03						2.8E-06	
1.3E-01	C	3.7E-05	C							Methylaniline Hydrochloride, 2-	636-21-5	5.2E-01	1.2E+01		5.0E-01						2.1E-04	
				1.0E-02	A					Methylarsonic acid	124-58-3					1.6E+02	2.6E+05		1.6E+02			
				2.0E-04	X					Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					3.1E+00			3.1E+00			
1.0E-01	X			3.0E-04	X					Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	6.7E-01			6.7E-01	4.7E+00			4.7E+00			
2.2E+01	C	6.3E-03	C						M	Methylcholanthrene, 3-	56-49-5	9.8E-04			9.8E-04						1.9E-03	
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	Methylene Chloride	75-09-2	1.1E+01	3.2E+02	1.9E+02	9.9E+00	9.4E+01	2.5E+03	1.3E+03	8.4E+01	5.0E+00	2.5E-03	1.3E-03
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.2E-01	4.0E-01		1.4E-01	3.1E+01	5.3E+01		2.0E+01		1.6E-03	
4.6E-02	I	1.3E-05	C							Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.5E+00	5.7E-01		4.1E-01						2.3E-03	
1.6E+00	C	4.6E-04	C			2.0E-02	C			Methylenebisbenzenamine, 4,4'-	101-77-9	4.2E-02	1.4E+00		4.1E-02						1.8E-04	
						6.0E-04	I			Methylenediphenyl Diisocyanate	101-68-8											
				7.0E-02	H			V		Methylstyrene, Alpha-	98-83-9					1.1E+03	1.2E+03		5.8E+02		9.3E-01	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.5E-01	I					Metolachlor	51218-45-2					2.3E+03	1.9E+04		2.1E+03		2.5E+00	
				2.5E-02	I					Metribuzin	21087-64-9					3.9E+02	1.3E+04		3.8E+02		1.2E-01	
				3.0E+00	P			V		Mineral oils	8012-95-1					4.7E+04			4.7E+04		1.9E+03	
1.8E+01	C	5.1E-03	C	2.0E-04	I					Mirex	2385-85-5	3.7E-03			3.7E-03	3.1E+00			3.1E+00		2.7E-03	
				2.0E-03	I					Molinate	2212-67-1					3.1E+01	8.4E+01		2.3E+01		1.3E-02	
				5.0E-03	I					Molybdenum	7439-98-7					7.8E+01	1.2E+04		7.8E+01		1.6E+00	
				1.0E-01	I					Monochloramine	10599-90-3					1.6E+03	2.4E+05		1.6E+03	4.0E+03		
				2.0E-03	P					Monomethylaniline	100-61-8					3.1E+01	5.3E+02		3.0E+01		1.1E-02	
				3.0E-04	X					N,N'-Diphenyl-1,4-benzenediamine	74-31-7					4.7E+00	6.3E+00		2.7E+00		2.8E-01	
				2.0E-03	I					Naled	300-76-5					3.1E+01	4.8E+03		3.1E+01		1.4E-02	
				3.0E-02	X	1.0E-01	P	V		Naphtha, High Flash Aromatic (HFAN)	64724-95-6					4.7E+02		2.1E+02	1.4E+02			
1.8E+00	C	0.0E+00	C							Naphthylamine, 2-	91-59-8	3.7E-02	3.1E-01		3.3E-02						1.7E-04	
				1.0E-01	I					Napropamide	15299-99-7					1.6E+03	6.4E+03		1.3E+03		8.3E+00	
				1.1E-02	C	1.4E-05	C			Nickel Carbonyl	13463-39-3					1.7E+02	1.0E+03		1.5E+02			
				1.1E-02	C	2.0E-05	C			Nickel Oxide	1313-99-1					1.7E+02	2.6E+04		1.7E+02			
		2.4E-04	I	1.1E-02	C	1.4E-05	C			Nickel Refinery Dust	NA					1.7E+02	5.2E+03		1.7E+02		2.5E+01	
		2.6E-04	C	2.0E-02	I	9.0E-05	A			Nickel Soluble Salts	7440-02-0					3.1E+02	9.5E+03		3.0E+02		2.0E+01	
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C			Nickel Subsulfide	12035-72-2	4.0E-02	1.5E+00		3.9E-02	1.7E+02	5.2E+03		1.7E+02			
				1.6E+00	I					Nitrate	14797-55-8					2.5E+04	3.8E+06		2.5E+04	1.0E+04		
										Nitrate + Nitrite (as N)	NA									1.0E+04		
				1.0E-01	I					Nitrite	14797-65-0					1.6E+03	2.4E+05		1.6E+03	1.0E+03		
				1.0E-02	X	5.0E-05	X			Nitroaniline, 2-	88-74-4					1.6E+02	2.4E+03		1.5E+02		6.2E-02	
2.0E-02	P			4.0E-03	P	6.0E-03	P			Nitroaniline, 4-	100-01-6	3.4E+00	1.1E+02		3.3E+00	6.3E+01	2.0E+03		6.1E+01		1.4E-03	
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		Nitrobenzene	98-95-3			1.2E-01	1.2E-01	3.1E+01	4.4E+02	1.9E+01	1.1E+01		7.9E-05	
				3.0E+03	P					Nitrocellulose	9004-70-0					4.7E+07			4.7E+07		1.0E+04	
				7.0E-02	H					Nitrofurantoin	67-20-9					1.1E+03	1.1E+06		1.1E+03		4.7E-01	
1.3E+00	C	3.7E-04	C							Nitrofurazone	59-87-0	5.2E-02	1.4E+01		5.2E-02						4.6E-05	
1.7E-02	P			1.0E-04	P					Nitroglycerin	55-63-0	4.0E+00	1.6E+02		3.9E+00	1.6E+00	6.2E+01		1.5E+00		6.6E-04	
				1.0E-01	I					Nitroguanidine	556-88-7					1.6E+03	1.3E+06		1.6E+03		3.8E-01	
		9.0E-06	P			2.0E-02	P	V		Nitromethane	75-52-5			5.4E-01	5.4E-01			4.2E+01	4.2E+01		1.2E-04	
		2.7E-03	H			2.0E-02	I	V		Nitropropane, 2-	79-46-9			1.8E-03	1.8E-03			4.2E+01	4.2E+01		4.7E-07	
2.7E+01	C	7.7E-03	C						M	Nitroso-N-ethylurea, N-	759-73-9	8.0E-04	1.4E-01		7.9E-04						1.9E-07	
1.2E+02	C	3.4E-02	C						M	Nitroso-N-methylurea, N-	684-93-5	1.8E-04	4.3E-02		1.8E-04						4.0E-08	
5.4E+00	I	1.6E-03	I					V		Nitroso-di-N-butylamine, N-	924-16-3	1.2E-02	6.7E-02	3.0E-03	2.4E-03						4.8E-06	
7.0E+00	I	2.0E-03	C							Nitroso-di-N-propylamine, N-	621-64-7	9.6E-03	3.0E-01		9.3E-03						7.0E-06	
2.8E+00	I	8.0E-04	C							Nitrosodiethanolamine, N-	1116-54-7	2.4E-02	6.9E+01		2.4E-02						4.8E-06	
1.5E+02	I	4.3E-02	I						M	Nitrosodiethylamine, N-	55-18-5	1.4E-04	1.6E-02		1.4E-04						5.2E-08	
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	Nitrosodimethylamine, N-	62-75-9	4.2E-04	1.9E-01		4.2E-04	1.3E-01	4.9E+01		1.2E-01		1.0E-07	
4.9E-03	I	2.6E-06	C							Nitrosodiphenylamine, N-	86-30-6	1.4E+01	4.4E+01		1.0E+01						5.7E-02	
2.2E+01	I	6.3E-03	C							Nitrosomethylethylamine, N-	10595-95-6	3.1E-03	5.5E-01		3.0E-03						8.7E-07	
6.7E+00	C	1.9E-03	C							Nitrosomorpholine [N-]	59-89-2	1.0E-02	4.5E+00		1.0E-02						2.5E-06	
9.4E+00	C	2.7E-03	C							Nitrosopiperidine [N-]	100-75-4	7.2E-03	9.3E-01		7.1E-03						3.8E-06	
2.1E+00	I	6.1E-04	I							Nitrosopyrrolidine, N-	930-55-2	3.2E-02	8.8E+00		3.2E-02						1.2E-05	
				1.0E-04	X					Nitrotoluene, m-	99-08-1					1.6E+00	9.7E+00		1.3E+00		1.2E-03	
2.2E-01	P			9.0E-04	P			V		Nitrotoluene, o-	88-72-2	3.1E-01	2.4E+00		2.7E-01	1.4E+01	1.1E+02		1.2E+01		2.5E-04	
1.6E-02	P			4.0E-03	P					Nitrotoluene, p-	99-99-0	4.2E+00	2.9E+01		3.7E+00	6.3E+01	4.4E+02		5.5E+01		3.4E-03	
				3.0E-04	X	2.0E-01	P	V		Nonane, n-	111-84-2					4.7E+00		4.2E+02	4.6E+00		6.6E-02	
				4.0E-02	I					Norflurazon	27314-13-2					6.3E+02	1.4E+04		6.0E+02		3.9E+00	
				7.0E-04	I					Nustar	85509-19-9					1.1E+01	3.5E+01		8.3E+00		1.4E+00	
				3.0E-03	I					Octabromodiphenyl Ether	32536-52-0					4.7E+01			4.7E+01		9.3E+00	
				5.0E-02	I					Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					7.8E+02	4.5E+05		7.8E+02		9.9E-01	
				2.0E-03	H					Octamethylpyrophosphoramide	152-16-9					3.1E+01	1.0E+05		3.1E+01		7.5E-03	
				1.0E-02	P					Octyl Phthalate, di-N-	117-84-0					1.6E+02			1.6E+02		4.4E+01	
				5.0E-02	I					Oryzalin	19044-88-3					7.8E+02	2.9E+03		6.2E+02		1.1E+00	
				5.0E-03	I					Oxadiazon	19666-30-9					7.8E+01	6.4E+01		3.5E+01		3.6E-01	
				2.5E-02	I					Oxamyl	23135-22-0					3.9E+02	3.6E+05		3.9E+02	2.0E+02	8.6E-02	4.4E-02
				1.3E-02	I					Paclobutrazol	76738-62-0					2.0E+02	1.2E+03		1.7E+02		3.6E-01	
				4.5E-03	I					Paraquat Dichloride	1910-42-5					7.0E+01			7.0E+01		9.7E-01	
				6.0E-03	H					Parathion	56-38-2					9.4E+01	2.1E+02		6.5E+01		3.3E-01	
				5.0E-02	H					Pebulate	1114-71-2					7.8E+02	9.0E+02		4.2E+02		3.3E-01	
				4.0E-02	I					Pendimethalin	40487-42-1					6.3E+02	1.7E+02		1.3E+02		1.5E+00	
				2.0E-03	I					Pentabromodiphenyl Ether	32534-81-9					3.1E+01			3.1E+01		1.4E+00	
				1.0E-04	I					Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					1.6E+00			1.6E+00		6.8E-02	
				8.0E-04	I					Pentachlorobenzene	608-93-5					1.3E+01	2.8E+00		2.3E+00		1.7E-02	
9.0E-02	P									Pentachloroethane	76-01-7	7.5E-01	2.2E+00		5.6E-01						2.7E-04	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
2.6E-01	H			3.0E-03	I					Pentachloronitrobenzene	82-68-8	2.6E-01	1.7E-01		1.0E-01	4.7E+01	3.1E+01		1.9E+01		1.3E-03	
4.0E-01	I	5.1E-06	C	5.0E-03	I					Pentachlorophenol	87-86-5	1.7E-01	4.5E-02		3.5E-02	7.8E+01	2.1E+01		1.6E+01	1.0E+00	3.6E-04	1.0E-02
4.0E-03	X			2.0E-03	P					Pentaerythritol tetranitrate (PETN)	78-11-5	1.7E+01	3.7E+02		1.6E+01	3.1E+01	6.8E+02		3.0E+01		2.4E-02	
						1.0E+00	P	V		Pentane, n-	109-66-0							2.1E+03	2.1E+03		1.0E+01	
										Perchlorates												
				7.0E-04	I					~Ammonium Perchlorate	7790-98-9					1.1E+01	1.7E+03		1.1E+01			
				7.0E-04	I					~Lithium Perchlorate	7791-03-9					1.1E+01	1.7E+03		1.1E+01			
				7.0E-04	I					~Perchlorate and Perchlorate Salts	14797-73-0					1.1E+01	1.7E+03		1.1E+01	1.5E+01(F)		
				7.0E-04	I					~Potassium Perchlorate	7778-74-7					1.1E+01	8.3E+02		1.1E+01			
				7.0E-04	I					~Sodium Perchlorate	7601-89-0					1.1E+01	1.7E+03		1.1E+01			
				5.0E-02	I					Permethrin	52645-53-1					7.8E+02			7.8E+02		1.9E+02	
2.2E-03	C	6.3E-07	C							Phenacetin	62-44-2	3.1E+01	9.4E+02		3.0E+01						8.3E-03	
				2.5E-01	I					Phenmedipham	13684-63-4					3.9E+03	1.3E+04		3.0E+03		1.6E+01	
				3.0E-01	I	2.0E-01	C			Phenol	108-95-2					4.7E+03	9.6E+04		4.5E+03		2.6E+00	
				5.0E-04	X					Phenothiazine	92-84-2					7.8E+00	5.4E+00		3.2E+00		1.0E-02	
				6.0E-03	I					Phenylenediamine, m-	108-45-2					9.4E+01	3.4E+04		9.4E+01		2.5E-02	
4.7E-02	H									Phenylenediamine, o-	95-54-5	1.4E+00	2.5E+02		1.4E+00						3.8E-04	
				1.9E-01	H					Phenylenediamine, p-	106-50-3					3.0E+03	1.0E+06		3.0E+03		7.9E-01	
1.9E-03	H									Phenylphenol, 2-	90-43-7	3.5E+01	1.0E+02		2.6E+01						3.5E-01	
				2.0E-04	H					Phorate	298-02-2					3.1E+00	8.7E+00		2.3E+00		2.6E-03	
						3.0E-04	I	V		Phosgene	75-44-5											
				2.0E-02	I					Phosmet	732-11-6					3.1E+02	3.7E+03		2.9E+02		6.4E-02	
										Phosphates, Inorganic												
				4.9E+01	P					~Aluminum metaphosphate	13776-88-0					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Ammonium polyphosphate	68333-79-9					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Calcium pyrophosphate	7790-76-3					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Diammonium phosphate	7783-28-0					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Dicalcium phosphate	7757-93-9					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Dimagnesium phosphate	7782-75-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Dipotassium phosphate	7758-11-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Disodium phosphate	7558-79-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monoaluminum phosphate	13530-50-2					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monoammonium phosphate	7722-76-1					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monocalcium phosphate	7758-23-8					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monomagnesium phosphate	7757-86-0					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monopotassium phosphate	7778-77-0					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Monosodium phosphate	7558-80-7					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Polyphosphoric acid	8017-16-1					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Potassium tripolyphosphate	13845-36-8					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium acid pyrophosphate	7758-16-9					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium aluminum phosphate (acidic)	7785-88-8					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium aluminum phosphate (anhydrous)	10279-59-1					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium hexametaphosphate	10124-56-8					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium polyphosphate	68915-31-1					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium trimetaphosphate	7785-84-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Sodium tripolyphosphate	7758-29-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Tetrapotassium phosphate	7320-34-5					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Tetrasodium pyrophosphate	7722-88-5					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Tricalcium phosphate	7758-87-4					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Trimagnesium phosphate	7757-87-1					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Tripotassium phosphate	7778-53-2					7.6E+05	1.2E+08		7.6E+05			
				4.9E+01	P					~Trisodium phosphate	7601-54-9					7.6E+05	1.2E+08		7.6E+05			
				3.0E-04	I	3.0E-04	I			Phosphine	7803-51-2					4.7E+00	7.1E+02		4.7E+00			
				4.9E+01	P	1.0E-02	I			Phosphoric Acid	7664-38-2					7.6E+05	1.2E+08		7.6E+05			
				2.0E-05	I					Phosphorus, White	7723-14-0					3.1E-01	4.7E+01		3.1E-01		1.1E-03	
				1.0E+00	H					Phthalic Acid, P-	100-21-0					1.6E+04	2.3E+05		1.5E+04		5.3E+00	
				2.0E+00	I	2.0E-02	C			Phthalic Anhydride	85-44-9					3.1E+04	7.6E+05		3.0E+04		6.6E+00	
				7.0E-02	I					Picloram	1918-02-1					1.1E+03	3.1E+04		1.1E+03	5.0E+02	2.9E-01	1.4E-01
				1.0E-04	X					Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					1.6E+00	1.5E+02		1.5E+00		1.0E-03	
				1.0E-02	I					Pirimiphos, Methyl	29232-93-7					1.6E+02	2.2E+02		9.1E+01		8.7E-02	
3.0E+01	C	8.6E-03	C	7.0E-06	H					Polybrominated Biphenyls	59536-65-1	2.2E-03			2.2E-03	1.1E-01			1.1E-01			
										Polychlorinated Biphenyls (PCBs)												
7.0E-02	S	2.0E-05	S	7.0E-05	I					~Aroclor 1016	12674-11-2	9.6E-01			9.6E-01	1.1E+00			1.1E+00		9.2E-02	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
2.0E+00	S	5.7E-04	S					V		~Aroclor 1221	11104-28-2	3.4E-02	1.0E-02	8.5E-03	4.0E-03						6.9E-05	
2.0E+00	S	5.7E-04	S					V		~Aroclor 1232	11141-16-5	3.4E-02	1.0E-02	8.5E-03	4.0E-03						6.9E-05	
2.0E+00	S	5.7E-04	S							~Aroclor 1242	53469-21-9	3.4E-02			3.4E-02						5.3E-03	
2.0E+00	S	5.7E-04	S							~Aroclor 1248	12672-29-6	3.4E-02			3.4E-02						5.2E-03	
2.0E+00	S	5.7E-04	S	2.0E-05	I					~Aroclor 1254	11097-69-1	3.4E-02			3.4E-02	3.1E-01			3.1E-01		8.8E-03	
2.0E+00	S	5.7E-04	S							~Aroclor 1260	11096-82-5	3.4E-02			3.4E-02						2.4E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.7E-02			1.7E-02	3.7E-01			3.7E-01		1.2E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.7E-02			1.7E-02	3.7E-01			3.7E-01		7.2E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.7E-02			1.7E-02	3.7E-01			3.7E-01		7.4E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.7E-02			1.7E-02	3.7E-01			3.7E-01		7.4E-03	
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E			~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.7E-05			1.7E-05	3.7E-04			3.7E-04		7.2E-06	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.7E-02			1.7E-02	3.7E-01			3.7E-01		4.5E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.7E-02			1.7E-02	3.7E-01			3.7E-01		4.4E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.7E-02			1.7E-02	3.7E-01			3.7E-01		4.5E-03	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E			~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.7E-02			1.7E-02	3.7E-01			3.7E-01		4.5E-03	
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E			~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	5.2E-06			5.2E-06	1.1E-04			1.1E-04		1.3E-06	
2.0E+00	I	5.7E-04	I							~Polychlorinated Biphenyls (high risk)	1336-36-3											
4.0E-01	I	1.0E-04	I							~Polychlorinated Biphenyls (low risk)	1336-36-3	1.7E-01			1.7E-01					5.0E-01	2.6E-02	7.8E-02
7.0E-02	I	2.0E-05	I							~Polychlorinated Biphenyls (lowest risk)	1336-36-3											
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	5.2E-03			5.2E-03	1.1E-01			1.1E-01		8.1E-04	
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E			~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.7E-03			1.7E-03	3.7E-02			3.7E-02		2.7E-04	
						6.0E-04	I			Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9											
										Polynuclear Aromatic Hydrocarbons (PAHs)												
				6.0E-02	I			V		~Acenaphthene	83-32-9					9.4E+02	6.8E+02		4.0E+02		4.1E+00	
				3.0E-01	I			V		~Anthracene	120-12-7					4.7E+03	1.8E+03		1.3E+03		4.2E+01	
7.3E-01	E	1.1E-04	C						M	~Benz[a]anthracene	56-55-3	2.9E-02			2.9E-02						1.0E-02	
1.2E+00	C	1.1E-04	C							~Benzo(j)fluoranthene	205-82-3	5.6E-02			5.6E-02						6.7E-02	
7.3E+00	I	1.1E-03	C						M	~Benzo[a]pyrene	50-32-8	2.9E-03			2.9E-03					2.0E-01	3.5E-03	2.4E-01
7.3E-01	E	1.1E-04	C						M	~Benzo[b]fluoranthene	205-99-2	2.9E-02			2.9E-02						3.5E-02	
7.3E-02	E	1.1E-04	C						M	~Benzo[k]fluoranthene	207-08-9	2.9E-01			2.9E-01						3.5E-01	
7.3E-03	E	1.1E-05	C						M	~Chrysene	218-01-9	2.9E+00			2.9E+00						1.1E+00	
7.3E+00	E	1.2E-03	C						M	~Dibenz[a,h]anthracene	53-70-3	2.9E-03			2.9E-03						1.1E-02	
1.2E+01	C	1.1E-03	C							~Dibenzo(a,e)pyrene	192-65-4	5.6E-03			5.6E-03						7.3E-02	
2.5E+02	C	7.1E-02	C						M	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	8.6E-05			8.6E-05						8.5E-05	
				4.0E-02	I					~Fluoranthene	206-44-0					6.3E+02			6.3E+02		7.0E+01	
				4.0E-02	I			V		~Fluorene	86-73-7					6.3E+02	3.3E+02		2.2E+02		4.0E+00	
7.3E-01	E	1.1E-04	C						M	~Indeno[1,2,3-cd]pyrene	193-39-5	2.9E-02			2.9E-02						2.0E-01	
2.9E-02	P			7.0E-02	A			V		~Methylnaphthalene, 1-	90-12-0	2.3E+00	1.7E+00		9.7E-01	1.1E+03	7.9E+02		4.6E+02		5.1E-03	
				4.0E-03	I			V		~Methylnaphthalene, 2-	91-57-6					6.3E+01	4.6E+01		2.7E+01		1.4E-01	
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		~Naphthalene	91-20-3			1.4E-01	1.4E-01	3.1E+02	5.0E+02	6.3E+00	6.1E+00		4.7E-04	
1.2E+00	C	1.1E-04	C							~Nitropyrene, 4-	57835-92-4	5.6E-02	2.3E-02		1.6E-02						2.8E-03	
				3.0E-02	I			V		~Pyrene	129-00-0					4.7E+02	1.1E+02		8.7E+01		9.5E+00	
1.5E-01	I			9.0E-03	I					Prochloraz	67747-09-5	4.5E-01	1.2E+00		3.2E-01	1.4E+02	3.6E+02		1.0E+02		1.6E-03	
				6.0E-03	H					Profluralin	26399-36-0					9.4E+01	2.3E+01		1.9E+01		1.2E+00	
				1.5E-02	I					Prometon	1610-18-0					2.3E+02	1.1E+03		1.9E+02		9.2E-02	
				4.0E-03	I					Prometryn	7287-19-6					6.3E+01	1.7E+02		4.5E+01		6.9E-02	
				1.3E-02	I					Propachlor	1918-16-7					2.0E+02	3.1E+03		1.9E+02		1.2E-01	
				5.0E-03	I					Propanil	709-98-8					7.8E+01	3.1E+02		6.3E+01		3.5E-02	
				2.0E-02	I					Propargite	2312-35-8					3.1E+02	1.9E+02		1.2E+02		8.8E+00	
				2.0E-03	I					Propargyl Alcohol	107-19-7					3.1E+01	7.8E+03		3.1E+01		6.4E-03	
				2.0E-02	I					Propazine	139-40-2					3.1E+02	1.7E+03		2.6E+02		2.3E-01	
				2.0E-02	I					Propham	122-42-9					3.1E+02	2.0E+03		2.7E+02		1.7E-01	
				1.3E-02	I					Propiconazole	60207-90-1					2.0E+02	7.5E+02		1.6E+02		5.3E-01	
						8.0E-03	I	V		Propionaldehyde	123-38-6							1.7E+01	1.7E+01		3.4E-03	
				1.0E-01	X	1.0E+00	X	V		Propyl benzene	103-65-1					1.6E+03	1.3E+03	2.1E+03	5.3E+02		9.9E-01	
						3.0E+00	C	V		Propylene	115-07-1							6.3E+03	6.3E+03		6.0E+00	
				2.0E+01	P					Propylene Glycol	57-55-6					3.1E+05	2.1E+08		3.1E+05		6.3E+01	
						2.7E-04	A			Propylene Glycol Dinitrate	6423-43-4											
				7.0E-01	H					Propylene Glycol Monoethyl Ether	1569-02-4					1.1E+04	2.2E+06		1.1E+04		2.2E+00	
				7.0E-01	H	2.0E+00	I			Propylene Glycol Monomethyl Ether	107-98-2					1.1E+04	2.7E+06		1.1E+04		2.2E+00	
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		Propylene Oxide	75-56-9	2.8E-01	4.0E+01	1.3E+00	2.3E-01			6.3E+01	6.3E+01		4.8E-05	
				2.5E-01	I					Pursuit	81335-77-5					3.9E+03	5.1E+04		3.6E+03		3.2E+00	
				2.5E-02	I					Pydrin	51630-58-1					3.9E+02			3.9E+02		2.5E+02	
				1.0E-03	I			V		Pyridine	110-86-1					1.6E+01	9.9E+02		1.5E+01		5.3E-03	
				5.0E-04	I					Quinalphos	13593-03-8					7.8E+00	7.3E+00		3.8E+00		3.2E-02	

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Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
3.0E+00	I									Quinoline	91-22-5	2.2E-02	2.5E-01		2.1E-02						6.8E-05	
						3.0E-02	A			Refractory Ceramic Fibers	NA											
				3.0E-02	I					Resmethrin	10453-86-8					4.7E+02	5.4E+01		4.8E+01		3.0E+01	
				5.0E-02	H					Ronnel	299-84-3					7.8E+02	4.8E+02		3.0E+02		2.7E+00	
				4.0E-03	I					Rotenone	83-79-4					6.3E+01	1.8E+02		4.7E+01		2.4E+01	
2.2E-01	C	6.3E-05	C						M	Safrole	94-59-7	9.8E-02	5.6E-01		8.3E-02						5.1E-05	
				2.5E-02	I					Savey	78587-05-0					3.9E+02	1.0E+02		8.1E+01		3.6E-01	
				5.0E-03	I					Selenious Acid	7783-00-8					7.8E+01	1.2E+04		7.8E+01			
				5.0E-03	I	2.0E-02	C			Selenium	7782-49-2					7.8E+01	1.2E+04		7.8E+01	5.0E+01	4.0E-01	2.6E-01
				5.0E-03	C	2.0E-02	C			Selenium Sulfide	7446-34-6					7.8E+01	1.2E+04		7.8E+01			
				9.0E-02	I					Sethoxydim	74051-80-2					1.4E+03	1.7E+03		7.8E+02		6.9E+00	
						3.0E-03	C			Silica (crystalline, respirable)	7631-86-9											
				5.0E-03	I					Silver	7440-22-4					7.8E+01	7.9E+02		7.1E+01		6.0E-01	
1.2E-01	H			5.0E-03	I					Simazine	122-34-9	5.6E-01	7.9E+00		5.2E-01	7.8E+01	1.1E+03		7.3E+01	4.0E+00	2.6E-04	2.0E-03
				1.3E-02	I					Sodium Acifluorfen	62476-59-9					2.0E+02	1.5E+05		2.0E+02		1.6E+00	
				4.0E-03	I					Sodium Azide	26628-22-8					6.3E+01	9.5E+03		6.2E+01			
2.7E-01	H			3.0E-02	I					Sodium Diethyldithiocarbamate	148-18-5	2.5E-01	7.3E+02		2.5E-01	4.7E+02	1.4E+06		4.7E+02			
				5.0E-02	A	1.3E-02	C			Sodium Fluoride	7681-49-4					7.8E+02	1.2E+05		7.8E+02			
				2.0E-05	I					Sodium Fluoroacetate	62-74-8					3.1E-01			3.1E-01		6.3E-05	
				1.0E-03	H					Sodium Metavanadate	13718-26-8					1.6E+01	2.4E+03		1.6E+01			
2.4E-02	H			3.0E-02	I					Stirofos (Tetrachlorovinphos)	961-11-5	2.8E+00	1.6E+01		2.4E+00	4.7E+02	2.7E+03		4.0E+02		7.0E-03	
				6.0E-01	I					Strontium, Stable	7440-24-6					9.4E+03	1.4E+06		9.3E+03		3.3E+02	
				3.0E-04	I					Strychnine	57-24-9					4.7E+00	2.3E+02		4.6E+00		5.1E-02	
				2.0E-01	I	1.0E+00	I	V		Styrene	100-42-5					3.1E+03	7.1E+03	2.1E+03	1.1E+03	1.0E+02	1.2E+00	1.1E-01
				1.0E-03	P	2.0E-03	P			Sulfolane	126-33-0					1.6E+01	1.2E+04		1.6E+01		3.4E-03	
				8.0E-04	P					Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					1.3E+01	2.5E+01		8.3E+00		4.9E-02	
						1.0E-03	C			Sulfuric Acid	7664-93-9											
				2.5E-02	I					Systhane	88671-89-0					3.9E+02	3.4E+03		3.5E+02		4.3E+00	
				3.0E-02	H					TCMTB	21564-17-0					4.7E+02	1.7E+03		3.7E+02		2.6E+00	
				7.0E-02	I					Tebuthiuron	34014-18-1					1.1E+03	3.3E+04		1.1E+03		3.0E-01	
				2.0E-02	H					Temephos	3383-96-8					3.1E+02			3.1E+02		6.0E+01	
				1.3E-02	I					Terbacil	5902-51-2					2.0E+02	4.9E+03		2.0E+02		5.9E-02	
				2.5E-05	H					Terbufos	13071-79-9					3.9E-01	3.2E-01		1.8E-01		3.9E-04	
				1.0E-03	I					Terbutryn	886-50-0					1.6E+01	2.9E+01		1.0E+01		1.4E-02	
				1.0E-04	I					Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					1.6E+00			1.6E+00		4.2E-02	
				3.0E-04	I					Tetrachlorobenzene, 1,2,4,5-	95-94-3					4.7E+00	1.7E+00		1.2E+00		5.8E-03	
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		Tetrachloroethane, 1,1,1,2-	630-20-6	2.6E+00	9.3E+00	6.6E-01	5.0E-01	4.7E+02	1.7E+03		3.7E+02		1.9E-04	
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		Tetrachloroethane, 1,1,2,2-	79-34-5	3.4E-01	2.8E+00	8.4E-02	6.6E-02	3.1E+02	2.6E+03		2.8E+02		2.6E-05	
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		Tetrachloroethylene	127-18-4	3.2E+01	5.6E+01	1.9E+01	9.7E+00	9.4E+01	1.6E+02	8.3E+01	3.5E+01	5.0E+00	4.4E-03	2.3E-03
				3.0E-02	I					Tetrachlorophenol, 2,3,4,6-	58-90-2					4.7E+02	2.8E+02		1.7E+02		1.1E+00	
2.0E+01	H									Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	3.4E-03	1.7E-03		1.1E-03						3.9E-06	
				5.0E-04	I					Tetraethyl Dithiopyrophosphate	3689-24-5					7.8E+00	1.7E+01		5.3E+00		3.9E-03	
						8.0E+01	I	V		Tetrafluoroethane, 1,1,1,2-	811-97-2							1.7E+05	1.7E+05		9.3E+01	
				4.0E-03	P					Tetryl (Trinitrophenylmethylnitramine)	479-45-8					6.3E+01	3.5E+03		6.1E+01		5.8E-01	
				7.0E-06	X					Thallium (I) Nitrate	10102-45-1					1.1E-01	1.7E+01		1.1E-01			
				1.0E-05	X					Thallium (Soluble Salts)	7440-28-0					1.6E-01	2.4E+01		1.6E-01	2.0E+00	1.1E-02	1.4E-01
				6.0E-06	X					Thallium Acetate	563-68-8					9.4E-02	1.4E+01		9.3E-02			
				2.0E-05	X					Thallium Carbonate	6533-73-9					3.1E-01	4.7E+01		3.1E-01			
				6.0E-06	X					Thallium Chloride	7791-12-0					9.4E-02	1.4E+01		9.3E-02			
				2.0E-05	X					Thallium Sulfate	7446-18-6					3.1E-01	4.7E+01		3.1E-01			
				1.0E-02	I					Thiobencarb	28249-77-6					1.6E+02	5.5E+02		1.2E+02		4.2E-01	
				7.0E-02	X					Thiodiglycol	111-48-8					1.1E+03	6.8E+05		1.1E+03		2.2E-01	
				3.0E-04	H					Thiofanox	39196-18-4					4.7E+00	3.1E+01		4.1E+00		1.4E-03	
				8.0E-02	I					Thiophanate, Methyl	23564-05-8					1.3E+03	1.5E+05		1.2E+03		1.1E+00	
				5.0E-03	I					Thiram	137-26-8					7.8E+01	2.8E+03		7.6E+01		1.1E-01	
				6.0E-01	H					Tin	7440-31-5					9.4E+03	1.4E+06		9.3E+03		2.3E+03	
						1.0E-04	A			Titanium Tetrachloride	7550-45-0											
				8.0E-02	I	5.0E+00	I	V		Toluene	108-88-3					1.3E+03	3.7E+03	1.0E+04	8.6E+02	1.0E+03	5.9E-01	6.9E-01
1.8E-01	X			2.0E-04	X					Toluene-2,5-diamine	95-70-5	3.7E-01	7.0E+01		3.7E-01	3.1E+00	5.9E+02		3.1E+00		1.2E-04	
3.0E-02	P			4.0E-03	X					Toluidine, p-	106-49-0	2.2E+00	5.8E+01		2.2E+00	6.3E+01	1.6E+03		6.0E+01		9.2E-04	
1.1E+00	I	3.2E-04	I							Toxaphene	8001-35-2	6.1E-02	1.7E-02		1.3E-02					3.0E+00	2.1E-03	4.6E-01
				7.5E-03	I					Tralomethrin	66841-25-6					1.2E+02			1.2E+02		4.5E+01	
				3.0E-04	A					Tri-n-butyltin	688-73-3					4.7E+00	7.0E+00		2.8E+00		6.2E-02	
				8.0E+01	X					Triacetin	102-76-1					1.3E+06	3.8E+08		1.2E+06		3.5E+02	
				1.3E-02	I					Triallate	2303-17-5					2.0E+02	1.5E+02		8.7E+01		1.9E-01	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; O = EPA Office of Water; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); SSL values are based on DAF=1

Toxicity and Chemical-specific Information										Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Hazard Index (HI) = 1					Protection of Groundwater SSL	
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	voc	muta-gen	Analyte	CAS No.	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (ug/L)	Inhalation SL TR=1.0E-6 (ug/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL HQ=1 (ug/L)	Dermal SL HQ=1 (ug/L)	Inhalation SL HQ=1 (ug/L)	Noncarcinogenic SL HI=1 (ug/L)	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
				1.0E-02	I					Triasulfuron	82097-50-5					1.6E+02	4.2E+04		1.6E+02		1.6E-01	
				5.0E-03	I					Tribromobenzene, 1,2,4-	615-54-3					7.8E+01	5.7E+01		3.3E+01		4.7E-02	
9.0E-03	P			1.0E-02	P					Tributyl Phosphate	126-73-8	7.5E+00	1.1E+01		4.5E+00	1.6E+02	2.3E+02		9.3E+01		2.2E-02	
				3.0E-04	P					Tributyltin Compounds	NA					4.7E+00			4.7E+00			
				3.0E-04	I					Tributyltin Oxide	56-35-9					4.7E+00	6.7E+01		4.4E+00		2.3E+02	
				3.0E+01	I	3.0E+01	H	V		Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					4.7E+05	1.4E+06	6.3E+04	5.3E+04		1.3E+02	
7.0E-02	I			2.0E-02	I					Trichloroacetic Acid	76-03-9	9.6E-01	3.9E+01		9.4E-01	3.1E+02	1.3E+04		3.1E+02	6.0E+01	1.9E-04	1.2E-02
2.9E-02	H									Trichloroaniline HCl, 2,4,6-	33663-50-2	2.3E+00	3.2E+03		2.3E+00						6.4E-03	
7.0E-03	X			3.0E-05	X					Trichloroaniline, 2,4,6-	634-93-5	9.6E+00	1.7E+01		6.1E+00	4.7E-01	8.3E-01		3.0E-01		2.7E-03	
				8.0E-04	X			V		Trichlorobenzene, 1,2,3-	87-61-6					1.3E+01	8.9E+00		5.2E+00		1.5E-02	
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		Trichlorobenzene, 1,2,4-	120-82-1	2.3E+00	1.7E+00		9.9E-01	1.6E+02	1.2E+02	4.2E+00	3.9E+00	7.0E+01	2.9E-03	2.0E-01
				2.0E+00	I	5.0E+00	I	V		Trichloroethane, 1,1,1-	71-55-6					3.1E+04	1.8E+05	1.0E+04	7.5E+03	2.0E+02	2.6E+00	7.0E-02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		Trichloroethane, 1,1,2-	79-00-5	1.2E+00	1.7E+01	3.0E-01	2.4E-01	6.3E+01	8.9E+02	4.2E-01	4.1E-01	5.0E+00	7.7E-05	1.6E-03
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	Trichloroethylene	79-01-6	1.0E+00	6.6E+00	8.6E-01	4.4E-01	7.8E+00	4.9E+01	4.2E+00	2.6E+00	5.0E+00	1.6E-04	1.8E-03
				3.0E-01	I	7.0E-01	H	V		Trichlorofluoromethane	75-69-4					4.7E+03	2.6E+04	1.5E+03	1.1E+03		6.9E-01	
				1.0E-01	I					Trichlorophenol, 2,4,5-	95-95-4					1.6E+03	2.0E+03		8.9E+02		3.3E+00	
1.1E-02	I	3.1E-06	I	1.0E-03	P					Trichlorophenol, 2,4,6-	88-06-2	6.1E+00	8.3E+00		3.5E+00	1.6E+01	2.1E+01		9.0E+00		1.3E-02	
				1.0E-02	I					Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					1.6E+02	6.2E+02		1.2E+02		5.2E-02	
				8.0E-03	I					Trichlorophenoxypropionic acid, -2,4,5	93-72-1					1.3E+02	2.6E+02		8.4E+01	5.0E+01	4.6E-02	2.8E-02
				5.0E-03	I			V		Trichloropropane, 1,1,2-	598-77-6					7.8E+01	5.3E+02		6.8E+01		2.7E-02	
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	Trichloropropane, 1,2,3-	96-18-4	7.2E-04	6.7E-03		6.5E-04	6.3E+01	5.4E+02	6.3E-01	6.2E-01		2.8E-07	
				3.0E-03	X	3.0E-04	P	V		Trichloropropene, 1,2,3-	96-19-5					4.7E+01	1.8E+02	6.3E-01	6.2E-01		3.1E-04	
				2.0E-02	A					Tricresyl Phosphate (TCP)	1330-78-5					3.1E+02	1.8E+02		1.2E+02		1.1E+01	
				3.0E-03	I					Tridiphane	58138-08-2					4.7E+01	1.8E+01		1.3E+01		9.3E-02	
						7.0E-03	I	V		Triethylamine	121-44-8							1.5E+01	1.5E+01		4.4E-03	
7.7E-03	I			7.5E-03	I					Trifluralin	1582-09-8	8.7E+00	2.9E+00		2.2E+00	1.2E+02	3.9E+01		2.9E+01		7.2E-02	
2.0E-02	P			1.0E-02	P					Trimethyl Phosphate	512-56-1	3.4E+00	2.4E+03		3.4E+00	1.6E+02	1.1E+05		1.6E+02		7.4E-04	
						5.0E-03	P	V		Trimethylbenzene, 1,2,3-	526-73-8							1.0E+01	1.0E+01		1.5E-02	
						7.0E-03	P	V		Trimethylbenzene, 1,2,4-	95-63-6							1.5E+01	1.5E+01		2.1E-02	
				1.0E-02	X			V		Trimethylbenzene, 1,3,5-	108-67-8					1.6E+02	2.0E+02		8.7E+01		1.2E-01	
				3.0E-02	I					Trinitrobenzene, 1,3,5-	99-35-4					4.7E+02	3.3E+04		4.6E+02		1.7E+00	
3.0E-02	I			5.0E-04	I					Trinitrotoluene, 2,4,6-	118-96-7	2.2E+00	9.1E+01		2.2E+00	7.8E+00	3.2E+02		7.6E+00		1.3E-02	
				2.0E-02	P					Triphenylphosphine Oxide	791-28-6					3.1E+02	2.7E+03		2.8E+02		1.2E+00	
				2.0E-02	A					Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					3.1E+02	2.3E+03		2.8E+02		6.2E+00	
				1.0E-02	X					Tris(1-chloro-2-propyl)phosphate	13674-84-5					1.6E+02	2.7E+03		1.5E+02		5.0E-01	
2.0E-02	P			7.0E-03	P					Tris(2-chloroethyl)phosphate	115-96-8	3.4E+00	2.5E+02		3.3E+00	1.1E+02	8.3E+03		1.1E+02		3.2E-03	
3.2E-03	P			1.0E-01	P					Tris(2-ethylhexyl)phosphate	78-42-2	2.1E+01			2.1E+01	1.6E+03			1.6E+03		1.0E+02	
				3.0E-03	I	4.0E-05	A			Uranium (Soluble Salts)	NA					4.7E+01	7.1E+03		4.7E+01	3.0E+01	2.1E+01	1.4E+01
1.0E+00	C	2.9E-04	C						M	Urethane	51-79-6	2.2E-02	5.6E+00		2.1E-02						4.8E-06	
		8.3E-03	P	9.0E-03	I	7.0E-06	P			Vanadium Pentoxide	1314-62-1					1.4E+02	5.5E+02		1.1E+02			
				5.0E-03	S	1.0E-04	A			Vanadium and Compounds	7440-62-2					7.9E+01	3.1E+02		6.3E+01		6.3E+01	
				1.0E-03	I					Vernolate	1929-77-7					1.6E+01	1.8E+01		8.3E+00		6.6E-03	
				2.5E-02	I					Vinclozolin	50471-44-8					3.9E+02	2.6E+03		3.4E+02		2.6E-01	
				1.0E+00	H	2.0E-01	I	V		Vinyl Acetate	108-05-4					1.6E+04	9.2E+05	4.2E+02	4.1E+02		8.7E-02	
		3.2E-05	H			3.0E-03	I	V		Vinyl Bromide	593-60-2			1.5E-01	1.5E-01			6.3E+00	6.3E+00		4.4E-05	
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	Vinyl Chloride	75-01-4	1.7E-02	2.6E-01	3.2E-01	1.5E-02	4.7E+01	5.8E+02	2.1E+02	3.6E+01	2.0E+00	5.3E-06	6.9E-04
				3.0E-04	I					Warfarin	81-81-2					4.7E+00	6.0E+01		4.4E+00		4.6E-03	
				2.0E-01	S	1.0E-01	S	V		Xylene, P-	106-42-3					3.1E+03	5.3E+03	2.1E+02	1.9E+02		1.8E-01	
				2.0E-01	S	1.0E-01	S	V		Xylene, m-	108-38-3					3.1E+03	4.9E+03	2.1E+02	1.9E+02		1.8E-01	
				2.0E-01	S	1.0E-01	S	V		Xylene, o-	95-47-6					3.1E+03	5.5E+03	2.1E+02	1.9E+02		1.9E-01	
				2.0E-01	I	1.0E-01	I	V		Xylenes	1330-20-7					3.1E+03	5.2E+03	2.1E+02	1.9E+02	1.0E+04	1.9E-01	9.8E+00
				3.0E-04	I					Zinc Phosphide	1314-84-7					4.7E+00	1.2E+03		4.7E+00			
				3.0E-01	I					Zinc and Compounds	7440-66-6					4.7E+03	1.2E+06		4.7E+03		2.9E+02	
				5.0E-02	I					Zineb	12122-67-7					7.8E+02	6.9E+04		7.7E+02		2.2E+00	
				8.0E-05	X					Zirconium	7440-67-7					1.3E+00	1.9E+02		1.2E+00		3.7E+00	

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
ALAR	1596-84-5	160.17	EPI	1.7294E-08	4.23E-10	EPI			0.064422	WATER9	7.5272E-06	WATER9	10	EPI	100000	EPI	0.0000199	EPI
Acephate	30560-19-1	183.16	EPI	2.048E-11	5.01E-13	EPI	1.35	CRC89	0.037354	WATER9	7.9758E-06	WATER9	10	EPI	818000	EPI	0.00004	EPI
Acetaldehyde	75-07-0	44.05	EPI	0.0027269	0.0000667	EPI	0.7834	CRC89	0.12771	WATER9	0.0000135	WATER9	1	EPI	1000000	EPI	0.000527	EPI
Acetochlor	34256-82-1	269.77	EPI	9.1169E-07	2.23E-08	EPI			0.045508	WATER9	5.3173E-06	WATER9	298.4	EPI	223	EPI	0.00495	EPI
Acetone	67-64-1	58.08	EPI	0.0014309	0.000035	EPI	0.7845	CRC89	0.105923	WATER9	0.0000115	WATER9	2.364	EPI	1000000	EPI	0.000512	EPI
Acetone Cyanohydrin	75-86-5	85.11	EPI	0.0005315	0.000013	EPI	0.932	CRC89	0.085946	WATER9	0.0000101	WATER9	1	EPI	1000000	EPI	0.000495	EPI
Acetonitrile	75-05-8	41.05	EPI	0.0014105	0.0000345	EPI	0.7857	CRC89	0.134	WATER9	0.0000141	WATER9	4.67	EPI	1000000	EPI	0.000548	EPI
Acetophenone	98-86-2	120.15	EPI	0.0004252	0.0000104	EPI	1.0281	CRC89	0.065222	WATER9	8.7229E-06	WATER9	51.85	EPI	6130	EPI	0.00372	EPI
Acetylaminofluorene, 2-	53-96-3	223.28	EPI	7.8496E-09	1.92E-10	EPI			0.051624	WATER9	6.0319E-06	WATER9	2206	EPI	8.4607	EPI	0.0124959	RAGSE
Acrolein	107-02-8	56.06	EPI	0.0049877	0.000122	EPI	0.84	CRC89	0.111693	WATER9	0.0000122	WATER9	1	EPI	212000	EPI	0.000748	EPI
Acrylamide	79-06-1	71.08	EPI	6.9501E-08	1.7E-09	EPI	1.222	LANGE	0.110399	WATER9	0.0000133	WATER9	5.694	EPI	390000	EPI	0.000224	EPI
Acrylic Acid	79-10-7	72.06	EPI	0.0000151	0.00000037	EPI	1.0511	CRC89	0.102722	WATER9	0.000012	WATER9	1.44	EPI	1000000	EPI	0.00105	EPI
Acrylonitrile	107-13-1	53.06	EPI	0.0056419	0.000138	EPI	0.8007	CRC89	0.11369	WATER9	0.0000123	WATER9	8.511	EPI	74500	EPI	0.00116	EPI
Adiponitrile	111-69-3	108.14	EPI	4.9469E-08	1.21E-09	EPI	0.9676	CRC89	0.070778	WATER9	8.9598E-06	WATER9	20.18	EPI	80000	EPI	0.000237	EPI
Alachlor	15972-60-8	269.77	EPI	3.4015E-07	8.32E-09	EPI	1.133	CRC89	0.022641	WATER9	5.6913E-06	WATER9	312.3	EPI	240	EPI	0.0105	EPI
Aldicarb	116-06-3	190.26	EPI	5.8872E-08	1.44E-09	EPI	1.195	CRC89	0.031868	WATER9	7.2458E-06	WATER9	24.64	EPI	6030	EPI	0.000755	EPI
Aldicarb Sulfone	1646-88-4	222.26	EPI	1.3778E-07	3.37E-09	EPI			0.051782	WATER9	6.0503E-06	WATER9	10	EPI	10000	EPI	0.0000371	EPI
Aldicarb sulfoxide	1646-87-3	206.26	EPI	3.9616E-08	9.69E-10	EPI			0.054427	WATER9	6.3593E-06	WATER9	10	EPI	28000	EPI	0.0000329	EPI
Aldrin	309-00-2	364.92	EPI	0.0017989	0.000044	EPI			0.037207	WATER9	4.3473E-06	WATER9	82020	EPI	0.017	EPI	0.293	EPI
Ally	74223-64-6	381.37	EPI	5.397E-15	1.32E-16	EPI			0.036129	WATER9	4.2214E-06	WATER9	92.5	EPI	9500	EPI	0.000329	EPI
Allyl Alcohol	107-18-6	58.08	EPI	0.000204	0.00000499	EPI	0.854	CRC89	0.109755	WATER9	0.0000121	WATER9	1.904	EPI	1000000	EPI	0.000959	EPI
Allyl Chloride	107-05-1	76.53	EPI	0.4497138	0.011	EPI	0.9376	CRC89	0.093607	WATER9	0.0000108	WATER9	39.6	EPI	3370	EPI	0.0112	EPI
Aluminum	7429-90-5	26.982	CRC89				2.7	CRC89									0.001	RAGSE
Aluminum Phosphide	20859-73-8	57.96	EPI				2.4	CRC89									0.001	RAGSE
Amdro	67485-29-4	494.49	EPI	0.0000899	0.0000022	EPI			0.030384	WATER9	3.5502E-06	WATER9	179700000	EPI	0.006	EPI	0.0000902	EPI
Ametryn	834-12-8	227.33	EPI	9.9346E-08	2.43E-09	EPI			0.051009	WATER9	0.00000596	WATER9	428.2	EPI	209	EPI	0.00794	EPI
Aminobiphenyl, 4-	92-67-1	169.23	EPI	7.0728E-06	0.000000173	EPI			0.062102	WATER9	7.2561E-06	WATER9	2471	EPI	128.81	EPI	0.014	EPI
Aminophenol, m-	591-27-5	109.13	EPI	1.0957E-08	2.68E-10	EPI			0.0832	WATER9	9.7213E-06	WATER9	90.2	EPI	27000	EPI	0.000527	EPI
Aminophenol, p-	123-30-8	109.13	EPI	1.4677E-08	3.59E-10	EPI			0.0832	WATER9	9.7213E-06	WATER9	90.2	EPI	16000	EPI	0.000407	EPI
Amitraz	33089-61-1	293.42	EPI	0.0004035	0.00000987	EPI	1.128	CRC89	0.021614	WATER9	5.3971E-06	WATER9	257300	EPI	1	EPI	0.16	EPI
Ammonia	7664-41-7	17.03	EPI	0.0006582	0.0000161	PHYSPROP	0.696	CRC89							899000	PERRY	0.001	RAGSE
Ammonium Sulfamate	7773-06-0	114.12	CRC89												147000	EPI	0.001	RAGSE
Aniline	62-53-3	93.13	EPI	0.0000826	0.00000202	EPI	1.0217	CRC89	0.083011	WATER9	0.0000101	WATER9	70.23	EPI	36000	EPI	0.00186	EPI
Anthraquinone, 9,10-	84-65-1	208.22	EPI	9.61E-07	2.35E-08	EPI			0.054084	WATER9	6.3193E-06	WATER9	5012	EPI	1.35	EPI	0.019	EPI
Antimony (metallic)	7440-36-0	121.76	CRC89				6.68	CRC89									0.001	RAGSE
Antimony Pentoxide	1314-60-9	323.52	CRC89				3.78	CRC89							3000	CRC89	0.001	RAGSE
Antimony Potassium Tartrate	11071-15-1	614.84	EPI												52600	EPI	0.001	RAGSE
Antimony Tetroxide	1332-81-6	307.52	EPI				6.64	CRC89									0.001	RAGSE
Antimony Trioxide	1309-64-4	291.52	EPI				5.58	CRC89									0.001	RAGSE
Apollo	74115-24-5	303.15	EPI	1.5944E-08	3.9E-10	EPI			0.042103	WATER9	4.9194E-06	WATER9	30210	EPI	1	EPI	0.00358	EPI
Aramite	140-57-8	334.86	EPI	7.7678E-06	0.00000019	EPI	1.143	CRC89	0.02029	WATER9	5.0255E-06	WATER9	5550	EPI	2.5922	EPI	0.0328	EPI
Arsenic, Inorganic	7440-38-2	74.922	CRC89				5.75	CRC89									0.001	RAGSE
Arsine	7784-42-1	77.95	EPI				3.186	CRC89							200000	PERRY	0.001	RAGSE
Assure	76578-14-8	372.81	EPI	4.3336E-07	1.06E-08	EPI			0.03668	WATER9	4.2858E-06	WATER9	7736	EPI	0.3	EPI	0.00886	EPI
Asulam	3337-71-1	230.24	EPI	6.991E-11	1.71E-12	EPI			0.050579	WATER9	5.9097E-06	WATER9	27.8	EPI	5000	EPI	0.0000529	EPI
Atrazine	1912-24-9	215.69	EPI	9.6484E-08	2.36E-09	EPI			0.052828	WATER9	6.1726E-06	WATER9	224.5	EPI	34.7	EPI	0.00524	EPI
Auramine	492-80-8	267.38	EPI	1.4881E-07	3.64E-09	EPI			0.045779	WATER9	5.3489E-06	WATER9	4456	EPI	10000	EPI	0.0111424	RAGSE
Avermectin B1	65195-55-3	875.12	EPI	5.397E-26	1.32E-27	EPI			0.020767	WATER9	2.4265E-06	WATER9	876700	EPI	1.4194	EPI	0.0000181	EPI
Azobenzene	103-33-3	182.23	EPI	0.0005519	0.0000135	EPI	1.203	PERRY	0.035909	WATER9	7.4655E-06	WATER9	3759	EPI	6.4	EPI	0.0514	EPI
Barium	7440-39-3	137.33	EPI				3.62	CRC89									0.001	RAGSE
Baygon	114-26-1	209.25	EPI	5.8463E-08	1.43E-09	EPI	1.12	CRC89	0.025745	WATER9	6.5827E-06	WATER9	59.95	EPI	1860	EPI	0.00107	EPI
Bayleton	43121-43-3	293.76	EPI	3.3156E-09	8.11E-11	EPI	1.22	CRC89	0.022429	WATER9	5.6532E-06	WATER9	298.5	EPI	71.5	EPI	0.00244	EPI
Baythroid	68359-37-5	434.3	EPI	1.1856E-06	0.000000029	EPI			0.03313	WATER9	3.871E-06	WATER9	130600	EPI	0.003	EPI	0.0515	EPI
Benefin	1861-40-1	335.29	EPI	0.011897	0.000291	EPI			0.039368	WATER9	4.5998E-06	WATER9	16390	EPI	0.1	EPI	0.0675	EPI
Benomyl	17804-35-2	290.32	EPI	2.016E-10	4.93E-12	EPI			0.043335	WATER9	5.0633E-06	WATER9	336.2	EPI	3.8	EPI	0.000943	EPI
Bentazon	25057-89-0	240.28	EPI	8.9125E-08	2.18E-09	EPI			0.04916	WATER9	5.7439E-06	WATER9	10	EPI	500	EPI	0.00252	EPI
Benzaldehyde	100-52-7	106.13	EPI	0.0010916	0.0000267	EPI	1.0401	CRC89	0.074393	WATER9	9.4627E-06	WATER9	11.09	EPI	6950	EPI	0.00383	EPI
Benzene	71-43-2	78.11	EPI	0.2269011	0.00555	EPI	0.8765	CRC89	0.089538	WATER9	0.0000103	WATER9	145.8	EPI	1790	EPI	0.0149	EPI
Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	220.24	EPI	8.86E-22	2.17E-23	EPI			0.052098	WATER9	6.0873E-06	WATER9	38.38	EPI	1000000	EPI	3.04E-07	EPI
Benzenethiol	108-98-5	110.17	EPI	0.0136958	0.000335	EPI	1.0775	CRC89	0.072863	WATER9	9.4511E-06	WATER9	233.9	EPI	835	EPI	0.0178	EPI
Benzidine	92-87-5	184.24	EPI	2.8823E-09	7.05E-11	EPI	1.219	Yaws 2008	0.035127	WATER9	7.4756E-06	WATER9	1190	EPI	322	EPI	0.00113	EPI
Benzoic Acid	65-85-0	122.12	EPI	1.5576E-06	3.81E-08	EPI	1.2659	CRC89	0.070194	WATER9	9.7868E-06	WATER9	16.55	EPI	3400	EPI	0.00565	EPI
Benzotrichloride	98-07-7	195.48	EPI	0.0106296	0.00026	EPI	1.3723	CRC89	0.031256	WATER9	7.746E-06	WATER9	1001	EPI	53	EPI	0.0487	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Benzyl Alcohol	100-51-6	108.14	EPI	0.0000138	0.000000337	EPI	1.0419	CRC89	0.073119	WATER9	9.3665E-06	WATER9	21.46	EPI	42900	EPI	0.00209	EPI
Benzyl Chloride	100-44-7	126.59	EPI	0.0168438	0.000412	EPI	1.1004	CRC89	0.063362	WATER9	8.8057E-06	WATER9	446.1	EPI	525	EPI	0.0103	EPI
Beryllium and compounds	7440-41-7	9.01	EPI				1.85	CRC89									0.001	RAGSE
Bidrin	141-66-2	237.19	EPI	2.0564E-09	5.03E-11	EPI	1.216	CRC89	0.025047	WATER9	6.4147E-06	WATER9	16.58	EPI	1000000	EPI	0.0000731	EPI
Bifenox	42576-02-3	342.14	EPI	4.4154E-06	0.000000108	EPI			0.038841	WATER9	4.5382E-06	WATER9	3679	EPI	0.398	EPI	0.0179	EPI
Biphenthrin	82657-04-3	422.88	EPI	0.0000409	0.000001	EPI	1.2	CRC89	0.018376	WATER9	4.4983E-06	WATER9	2272000	EPI	0.1	EPI	1.74	EPI
Biphenyl, 1,1'-	92-52-4	154.21	EPI	0.012592	0.000308	EPI	1.04	CRC89	0.047059	WATER9	7.5618E-06	WATER9	5129	EPI	6.94	EPI	0.0943	EPI
Bis(2-chloro-1-methylethyl) ether	108-60-1	171.07	EPI	0.0030335	0.0000742	EPI	1.103	CRC89	0.039889	WATER9	7.3606E-06	WATER9	82.92	EPI	1700	EPI	0.00764	EPI
Bis(2-chloroethoxy)methane	111-91-1	173.04	EPI	0.0001574	0.00000385	EPI			0.061187	WATER9	7.1492E-06	WATER9	14.38	EPI	7800	EPI	0.00122	EPI
Bis(2-chloroethyl)ether	111-44-4	143.01	EPI	0.000695	0.000017	EPI	1.22	CRC89	0.056719	WATER9	8.707E-06	WATER9	32.21	EPI	17200	EPI	0.00178	EPI
Bis(2-ethylhexyl)phthalate	117-81-7	390.57	EPI	0.000011	0.00000027	EPI	0.981	CRC89	0.01734	WATER9	4.1807E-06	WATER9	119600	EPI	0.27	EPI	1.13	EPI
Bis(chloromethyl)ether	542-88-1	114.96	EPI	0.1782502	0.00436	EPI	1.323	CRC89	0.0763	WATER9	0.0000104	WATER9	9.699	EPI	22000	EPI	0.000855	EPI
Bisphenol A	80-05-7	228.29	EPI	3.745E-10	9.16E-12	EPI			0.050866	WATER9	5.9433E-06	WATER9	37670	EPI	120	EPI	0.0132	EPI
Boron And Borates Only	7440-42-8	13.84	EPI				2.34	CRC89									0.001	RAGSE
Boron Trichloride	10294-34-5	117.17	CRC89				4.789	CRC89									0.001	RAGSE
Boron Trifluoride	7637-07-2	67.81	EPI				2.772	CRC89							3320000	EPI	0.001	RAGSE
Bromate	15541-45-4	79.9	EPI														0.001	RAGSE
Bromo-2-chloroethane, 1-	107-04-0	143.41	EPI	0.0371627	0.000909	EPI	1.7392	CRC89	0.065925	WATER9	0.0000108	WATER9	39.6	EPI	6900	PERRY	0.00464	EPI
Bromobenzene	108-86-1	157.01	EPI	0.1009812	0.00247	EPI	1.495	CRC89	0.053713	WATER9	9.3004E-06	WATER9	233.9	EPI	446	EPI	0.02	EPI
Bromochloromethane	74-97-5	129.38	EPI	0.0596893	0.00146	EPI	1.9344	CRC89	0.078692	WATER9	0.0000122	WATER9	21.73	EPI	16700	EPI	0.00255	EPI
Bromodichloromethane	75-27-4	163.83	EPI	0.0866721	0.00212	EPI	1.98	CRC89	0.056263	WATER9	0.0000107	WATER9	31.82	EPI	3030	EPI	0.00402	EPI
Bromoform	75-25-2	252.73	EPI	0.0218724	0.000535	EPI	2.8788	CRC89	0.035732	WATER9	0.0000104	WATER9	31.82	EPI	3100	EPI	0.00235	EPI
Bromomethane	74-83-9	94.94	EPI	0.3000818	0.00734	EPI	1.6755	CRC89	0.100497	WATER9	0.0000135	WATER9	13.22	EPI	15200	EPI	0.00284	EPI
Bromophos	2104-96-3	365.99	EPI	0.008381	0.000205	EPI			0.037134	WATER9	4.3388E-06	WATER9	2019	EPI	0.3	EPI	0.0401	EPI
Bromoxynil	1689-84-5	276.92	EPI	5.3966E-09	1.32E-10	EPI			0.044722	WATER9	5.2254E-06	WATER9	330.1	EPI	130	EPI	0.00783	EPI
Bromoxynil Octanoate	1689-99-2	403.12	EPI	0.0013042	0.0000319	EPI			0.034818	WATER9	4.0681E-06	WATER9	4252	EPI	0.08	EPI	0.0332	EPI
Butadiene, 1,3-	106-99-0	54.09	EPI	3.0089943	0.0736	EPI	0.6149	CRC89	0.100351	WATER9	0.0000103	WATER9	39.6	EPI	735	EPI	0.0164	EPI
Butanol, N-	71-36-3	74.12	EPI	0.0003602	0.00000881	EPI	0.8095	CRC89	0.090042	WATER9	0.0000101	WATER9	3.471	EPI	63200	EPI	0.00231	EPI
Butyl Benzyl Phthlate	85-68-7	312.37	EPI	0.0000515	0.00000126	EPI	1.119	CRC89	0.020832	WATER9	5.1733E-06	WATER9	7155	EPI	2.69	EPI	0.0385	EPI
Butyl alcohol, sec-	78-92-2	74.12	EPI	0.0003704	0.00000906	EPI	0.8063	CRC89	0.089889	WATER9	0.0000101	WATER9	2.919	EPI	181000	EPI	0.00153	EPI
Butylate	2008-41-5	217.37	EPI	0.0034546	0.0000845	EPI	0.9402	CRC89	0.023231	WATER9	5.7927E-06	WATER9	385.7	EPI	45	EPI	0.0541	EPI
Butylated hydroxyanisole	25013-16-5	180.25	EPI	0.0000478	0.00000117	EPI			0.059544	WATER9	6.9572E-06	WATER9	840.7	EPI	742.97	EPI	0.0325	EPI
Butylbenzene, n-	104-51-8	134.22	EPI	0.6500409	0.0159	EPI	0.8601	CRC89	0.052773	WATER9	7.3335E-06	WATER9	1482	EPI	11.8	EPI	0.225	EPI
Butylbenzene, sec-	135-98-8	134.22	EPI	0.7195421	0.0176	EPI	0.8608	LANGE	0.052793	WATER9	7.3371E-06	WATER9	1331	EPI	17.6	EPI	0.301	EPI
Butylbenzene, tert-	98-06-6	134.22	EPI	0.5396566	0.0132	EPI	0.8665	CRC89	0.052953	WATER9	7.3662E-06	WATER9	1001	EPI	29.5	EPI	0.149	EPI
Butylphthalyl Butylglycolate	85-70-1	336.39	EPI	1.2592E-07	3.08E-09	EPI	1.1	LANGE	0.019866	WATER9	4.8978E-06	WATER9	11240	EPI	8.4709	EPI	0.0116	EPI
Cacodylic Acid	75-60-5	138	EPI						0.071149	WATER9	8.3132E-06	WATER9	43.89	EPI	2000000	EPI	0.00046	EPI
Cadmium (Diet)	7440-43-9	112.41	EPI				8.69	CRC89									0.001	RAGSE
Cadmium (Water)	7440-43-9	112.41	EPI				8.69	CRC89									0.001	RAGSE
Caprolactam	105-60-2	113.16	EPI	1.0343E-06	2.53E-08	EPI	1.02	LANGE	0.069242	WATER9	8.9995E-06	WATER9	24.5	EPI	772000	EPI	0.001	EPI
Captafol	2425-06-1	349.06	EPI	2.0114E-07	4.92E-09	EPI			0.038325	WATER9	4.478E-06	WATER9	782.7	EPI	1.4	EPI	0.00577	EPI
Captan	133-06-2	300.59	EPI	2.8618E-07	0.000000007	EPI	1.74	CRC89	0.026194	WATER9	6.8995E-06	WATER9	252.2	EPI	5.1	EPI	0.00234	EPI
Carbaryl	63-25-2	201.23	EPI	1.3369E-07	3.27E-09	EPI	1.228	CRC89	0.027424	WATER9	7.1216E-06	WATER9	354.8	EPI	110	EPI	0.00431	EPI
Carbofuran	1563-66-2	221.26	EPI	1.2633E-07	3.09E-09	EPI	1.18	CRC89	0.025615	WATER9	6.5684E-06	WATER9	95.25	EPI	320	EPI	0.00313	EPI
Carbon Disulfide	75-15-0	76.13	EPI	0.5887163	0.0144	EPI	1.2632	CRC89	0.106447	WATER9	0.000013	WATER9	21.73	EPI	2160	EPI	0.0114	EPI
Carbon Tetrachloride	56-23-5	153.82	EPI	1.1283729	0.0276	EPI	1.594	CRC89	0.057144	WATER9	9.7849E-06	WATER9	43.89	EPI	793	EPI	0.0163	EPI
Carbosulfan	55285-14-8	380.55	EPI	0.0000209	0.000000512	EPI	1.056	CRC89	0.018239	WATER9	4.4384E-06	WATER9	11960	EPI	0.3	EPI	0.0579	EPI
Carboxin	5234-68-4	235.3	EPI	1.3083E-08	3.2E-10	EPI			0.049851	WATER9	5.8247E-06	WATER9	169.4	EPI	147	EPI	0.00198	EPI
Ceric oxide	1306-38-3	172.11	EPI				7.216	CRC89							107000	EPI	0.001	RAGSE
Chloral Hydrate	302-17-0	165.4	EPI	4.4563E-09	1.09E-10	EPI	1.9081	CRC89	0.054399	WATER9	0.0000104	WATER9	1	EPI	793000	EPI	0.000841	EPI
Chloramben	133-90-4	206.03	EPI	1.5822E-09	3.87E-11	EPI			0.054467	WATER9	6.364E-06	WATER9	21.37	EPI	700	EPI	0.00201	EPI
Chloranil	118-75-2	245.88	EPI	1.3369E-08	3.27E-10	EPI			0.04841	WATER9	5.6564E-06	WATER9	308.1	EPI	250	EPI	0.00194	EPI
Chlordane	12789-03-6	409.78	EPI	0.0019869	0.0000486	EPI			0.034439	WATER9	4.0239E-06	WATER9	33780	EPI	0.056	EPI	0.107	EPI
Chlordecone (Kepone)	143-50-0	490.64	EPI	2.1995E-06	5.38E-08	EPI	1.61	CRC89	0.019647	WATER9	4.9081E-06	WATER9	17500	EPI	2.7	EPI	0.0109	EPI
Chlorfenvinphos	470-90-6	359.58	EPI	1.1815E-06	2.89E-08	EPI			0.037574	WATER9	4.3903E-06	WATER9	1264	EPI	124	EPI	0.00512	EPI
Chlorimuron, Ethyl-	90982-32-4	414.82	EPI	7.441E-14	1.82E-15	EPI			0.03416	WATER9	3.9913E-06	WATER9	71.79	EPI	1200	EPI	0.000338	EPI
Chlorine	7782-50-5	70.91	EPI	0.4783	0.0117	PHYSPROP	2.898	CRC89							6300	EPI	0.001	RAGSE
Chlorine Dioxide	10049-04-4	67.45	EPI				2.757	CRC89									0.001	RAGSE
Chlorite (Sodium Salt)	7758-19-2	90.44	EPI												640000	CRC89	0.001	RAGSE
Chloro-1,1-difluoroethane, 1-	75-68-3	100.5	EPI	2.4039248	0.0588	EPI	1.107	CRC89	0.080393	WATER9	0.0000101	WATER9	43.89	EPI	1400	EPI	0.00989	EPI
Chloro-1,3-butadiene, 2-	126-99-8	88.54	EPI	2.29	0.0561	EPI	0.956	CRC89	0.084147	WATER9	0.00001	WATER9	60.7	EPI	836.92	EPI	0.0238	EPI
Chloro-2-methylaniline HCl, 4-	3165-93-3	178.06	EPI	5.887E-12	1.44E-13	EPI			0.060031	WATER9	7.0142E-06	WATER9	351.9	EPI	115.68	EPI	0.000018	EPI
Chloro-2-methylaniline, 4-	95-69-2	141.6	EPI	0.0000814	0.00000199	EPI			0.069938	WATER9	8.1717E-06	WATER9	184.5	EPI	1732.4	EPI	0.00808	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Chloroacetaldehyde, 2-	107-20-0	78.5	EPI	0.00074	0.0000181	EPI	1.19	CRC89	0.101505	WATER9	0.0000123	WATER9	1	EPI	266780	EPI	0.00065	EPI
Chloroacetic Acid	79-11-8	94.5	EPI	3.7858E-07	9.26E-09	EPI	1.4043	CRC89	0.093821	WATER9	0.0000121	WATER9	1.44	EPI	858000	EPI	0.000647	EPI
Chloroacetophenone, 2-	532-27-4	154.6	EPI	0.0001349	0.0000033	EPI	1.324	CRC89	0.052239	WATER9	8.7273E-06	WATER9	98.9	EPI	1100	PERRY	0.00406	EPI
Chloroaniline, p-	106-47-8	127.57	EPI	0.0000474	0.00000116	EPI	1.429	CRC89	0.070385	WATER9	0.0000103	WATER9	112.7	EPI	3900	EPI	0.00496	EPI
Chlorobenzene	108-90-7	112.56	EPI	0.1271464	0.00311	EPI	1.1058	CRC89	0.072131	WATER9	9.4765E-06	WATER9	233.9	EPI	498	EPI	0.0282	EPI
Chlorobenzilate	510-15-6	325.19	EPI	2.9599E-06	7.24E-08	EPI	1.2816	CRC89	0.021777	WATER9	5.4782E-06	WATER9	1539	EPI	13	EPI	0.0331	EPI
Chlorobenzoic Acid, p-	74-11-3	156.57	EPI	1.5863E-06	3.88E-08	EPI	1.541	PERRY	0.054689	WATER9	9.487E-06	WATER9	26.56	EPI	72	EPI	0.012	EPI
Chlorobenzotrifluoride, 4-	98-56-6	180.56	EPI	1.4186427	0.0347	EPI	1.334	CRC89	0.0385	WATER9	7.9872E-06	WATER9	1606	EPI	11.723	EPI	0.0375	EPI
Chlorobutane, 1-	109-69-3	92.57	EPI	0.6827473	0.0167	EPI	0.8857	CRC89	0.078413	WATER9	9.3274E-06	WATER9	72.17	EPI	1100	EPI	0.0269	EPI
Chlorodifluoromethane	75-45-6	86.47	EPI	1.6598528	0.0406	EPI	1.4909	CRC89	0.103378	WATER9	0.0000133	WATER9	31.82	EPI	2770	EPI	0.00268	EPI
Chloroethanol, 2-	107-07-3	80.51	EPI	0.0000311	0.000000761	EPI	1.2019	CRC89	0.099986	WATER9	0.0000122	WATER9	1.904	EPI	1000000	EPI	0.000579	EPI
Chloroform	67-66-3	119.38	EPI	0.1500409	0.00367	EPI	1.4788	CRC89	0.07692	WATER9	0.0000109	WATER9	31.82	EPI	7950	EPI	0.00683	EPI
Chloromethane	74-87-3	50.49	EPI	0.3605887	0.00882	EPI	0.911	CRC89	0.123962	WATER9	0.0000136	WATER9	13.22	EPI	5320	EPI	0.00328	EPI
Chloromethyl Methyl Ether	107-30-2	80.51	EPI	0.0124285	0.000304	EPI	1.063	CRC89	0.094973	WATER9	0.0000113	WATER9	5.322	EPI	192400	EPI	0.000905	EPI
Chloronaphthalene, Beta-	91-58-7	162.62	EPI	0.0130826	0.00032	EPI	1.1377	CRC89	0.044691	WATER9	7.7301E-06	WATER9	2478	EPI	11.7	EPI	0.0749	EPI
Chloronitrobenzene, o-	88-73-3	157.56	EPI	0.0003802	0.0000093	EPI	1.368	CRC89	0.051345	WATER9	8.7995E-06	WATER9	370.6	EPI	441	EPI	0.0063	EPI
Chloronitrobenzene, p-	100-00-5	157.56	EPI	0.0001999	0.00000489	EPI	1.2979	CRC89	0.050159	WATER9	8.5261E-06	WATER9	363.2	EPI	225	EPI	0.00793	EPI
Chlorophenol, 2-	95-57-8	128.56	EPI	0.0004579	0.0000112	EPI	1.2634	CRC89	0.066118	WATER9	9.4784E-06	WATER9	306.5	EPI	11300	EPI	0.00799	EPI
Chloropicrin	76-06-2	164.38	EPI	0.0838103	0.00205	EPI	1.6558	CRC89	0.051764	WATER9	9.6198E-06	WATER9	44.19	EPI	1620	EPI	0.00459	EPI
Chlorothalonil	1897-45-6	265.91	EPI	0.0000818	0.000002	EPI	1.7	CRC89	0.027579	WATER9	7.3232E-06	WATER9	1041	EPI	0.81	EPI	0.00537	EPI
Chlorotoluene, o-	95-49-8	126.59	EPI	0.1459526	0.00357	EPI	1.0825	CRC89	0.062903	WATER9	8.7194E-06	WATER9	382.9	EPI	374	EPI	0.0572	EPI
Chlorotoluene, p-	106-43-4	126.59	EPI	0.1790679	0.00438	EPI	1.0697	CRC89	0.062571	WATER9	8.6574E-06	WATER9	375.3	EPI	106	EPI	0.0498	EPI
Chlorozotocin	54749-90-5	313.7	EPI	1.5E-20	3.67E-22	EPI			0.041154	WATER9	4.8085E-06	WATER9	10	EPI	1000000	EPI	0.00000991	EPI
Chlorpropham	101-21-3	213.67	EPI	0.0000233	0.000000569	EPI	1.18	CRC89	0.026089	WATER9	6.7074E-06	WATER9	350.7	EPI	89	EPI	0.0213	EPI
Chlorpyrifos	2921-88-2	350.59	EPI	0.0001198	0.00000293	EPI			0.038214	WATER9	4.465E-06	WATER9	7283	EPI	1.12	EPI	0.0334	EPI
Chlorpyrifos Methyl	5598-13-0	322.53	EPI	0.0001533	0.00000375	EPI			0.040399	WATER9	4.7203E-06	WATER9	2193	EPI	4.76	EPI	0.0178	EPI
Chlorsulfuron	64902-72-3	357.77	EPI	1.398E-14	3.42E-16	EPI			0.037701	WATER9	4.405E-06	WATER9	322	EPI	31000	EPI	0.000328	EPI
Chlorthiophos	60238-56-4	361.24	EPI	0.0000491	0.0000012	EPI			0.037459	WATER9	4.3768E-06	WATER9	12790	EPI	0.3	EPI	0.106	EPI
Chromium(III), Insoluble Salts	16065-83-1	52	EPI				5.22	CRC89									0.001	RAGSE
Chromium(VI)	18540-29-9	52	EPI												1690000	CRC89	0.002	RAGSE
Chromium, Total	7440-47-3	52	EPI				7.15	CRC89									0.001	RAGSE
Cobalt	7440-48-4	58.93	EPI				8.86	CRC89									0.0004	RAGSE
Coke Oven Emissions	8007-45-2	78.11	EPI	0.2269011	0.00555	EPI			0.10398	WATER9	0.0000121	WATER9	145.8	EPI	1790	EPI	0.0149	EPI
Copper	7440-50-8	63.55	EPI				8.96	CRC89									0.001	RAGSE
Cresol, m-	108-39-4	108.14	EPI	0.000035	0.000000856	EPI	1.0339	CRC89	0.072872	WATER9	9.3232E-06	WATER9	300.4	EPI	22700	EPI	0.00777	EPI
Cresol, o-	95-48-7	108.14	EPI	0.0000491	0.0000012	EPI	1.0327	CRC89	0.072835	WATER9	9.3168E-06	WATER9	306.5	EPI	25900	EPI	0.00766	EPI
Cresol, p-	106-44-5	108.14	EPI	0.0000409	0.000001	EPI	1.0185	CRC89	0.072394	WATER9	9.2397E-06	WATER9	300.4	EPI	21500	EPI	0.00754	EPI
Cresol, p-chloro-m-	59-50-7	142.59	EPI	0.0001002	0.00000245	EPI			0.069614	WATER9	8.1338E-06	WATER9	491.8	EPI	3830	EPI	0.0285	EPI
Cresols	1319-77-3	108.14	EPI	0.0000491	0.0000012	EPI			0.083707	WATER9	9.7805E-06	WATER9	306.5	EPI	25900	EPI	0.00766	EPI
Crotonaldehyde, trans-	123-73-9	70.09	EPI	0.0007931	0.0000194	EPI	0.8516	CRC89	0.095926	WATER9	0.0000108	WATER9	1.793	EPI	150000	EPI	0.00159	EPI
Cumene	98-82-8	120.2	EPI	0.4701554	0.0115	EPI	0.864	CRC89	0.060304	WATER9	7.8566E-06	WATER9	697.8	EPI	61.3	EPI	0.0897	EPI
Cupferron	135-20-6	155.16	EPI	8.667E-16	2.12E-17	EPI			0.065801	WATER9	7.6883E-06	WATER9	762.4	EPI	204310	EPI	0.00000167	EPI
Cyanazine	21725-46-2	240.7	EPI	1.051E-10	2.57E-12	EPI			0.049102	WATER9	5.7372E-06	WATER9	134.1	EPI	170	EPI	0.00209	EPI
Cyanides																		
~Calcium Cyanide	592-01-8	92.11	EPI														0.001	RAGSE
~Copper Cyanide	544-92-3	89.56	EPI				2.9	CRC89							23	EPI	0.001	RAGSE
~Cyanide (CN-)	57-12-5	27.03	EPI	0.0054374	0.000133	EPI			0.210955	WATER9	0.0000246	WATER9			1000000	EPI	0.001	RAGSE
~Cyanogen	460-19-5	52.04	EPI	0.2207686	0.0054	EPI	0.9537	CRC89	0.123753	WATER9	0.0000138	WATER9			9487	YAWS	0.00089	RAGSE
~Cyanogen Bromide	506-68-3	105.92	EPI	1	0.0245	EPI	2.015	CRC89	0.098407	WATER9	0.0000141	WATER9					0.000255	RAGSE
~Cyanogen Chloride	506-77-4	61.47	EPI	0.0787186	0.0019412	YAWS	1.186	CRC89	0.120745	WATER9	0.0000142	WATER9			30000	YAWS	0.000394	RAGSE
~Hydrogen Cyanide	74-90-8	27.03	EPI	0.0054374	0.000133	EPI	0.6876	CRC89	0.167804	WATER9	0.0000168	WATER9			1000000	EPI	0.001	RAGSE
~Potassium Cyanide	151-50-8	65.12	EPI				1.55	CRC89							720000	EPI	0.002	RAGSE
~Potassium Silver Cyanide	506-61-6	199	EPI														0.002	RAGSE
~Silver Cyanide	506-64-9	133.89	EPI				3.95	CRC89							23	EPI	0.001	RAGSE
~Sodium Cyanide	143-33-9	49.01	EPI				1.6	CRC89							582000	CRC89	0.001	RAGSE
~Thiocyanates	NA																0.001	RAGSE
~Thiocyanic Acid	463-56-9	59.09	EPI				1.126	PPRTV									0.001	RAGSE
~Zinc Cyanide	557-21-1	117.43	EPI				1.852	CRC89							17100	EPI	0.0006	RAGSE
Cyclohexane	110-82-7	84.16	EPI	6.1324612	0.15	EPI	0.7739	CRC89	0.079975	WATER9	9.1079E-06	WATER9	145.8	EPI	55	EPI	0.102	EPI
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	513.09	EPI	4.374E-10	1.07E-11	EPI			0.029645	WATER9	3.4638E-06	WATER9	2807	EPI	0.45388	EPI	0.00283	EPI
Cyclohexanone	108-94-1	98.15	EPI	0.0003679	0.000009	EPI	0.9478	CRC89	0.076757	WATER9	9.3792E-06	WATER9	17.38	EPI	25000	EPI	0.00152	EPI
Cyclohexene	110-83-8	82.15	EPI	1.8601799	0.0455	EPI			0.100542	WATER9	0.0000117	WATER9	145.8	EPI	213	EPI	0.0431	EPI
Cyclohexylamine	108-91-8	99.18	EPI	0.0001701	0.00000416	EPI	0.8191	CRC89	0.071293	WATER9	8.5392E-06	WATER9	32.17	EPI	1000000	EPI	0.00425	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Cyhalothrin/karate	68085-85-8	449.86	EPI	0.0000605	0.00000148	EPI			0.032362	WATER9	3.7812E-06	WATER9	341300	EPI	0.005	EPI	0.21	EPI
Cypermethrin	52315-07-8	416.31	EPI	0.0000172	0.00000042	EPI	1.25	CRC89	0.018905	WATER9	4.6534E-06	WATER9	79750	EPI	0.004	EPI	0.0769	EPI
Cyromazine	66215-27-8	166.19	EPI	2.31E-12	5.65E-14	EPI			0.062857	WATER9	7.3443E-06	WATER9	28.73	EPI	13000	EPI	0.000797	EPI
DDD	72-54-8	320.05	EPI	0.0002698	0.0000066	EPI			0.040608	WATER9	4.7447E-06	WATER9	117500	EPI	0.09	EPI	0.251	EPI
DDE, p,p'-	72-55-9	318.03	EPI	0.0017007	0.0000416	EPI			0.04078	WATER9	4.7648E-06	WATER9	117500	EPI	0.04	EPI	0.545	EPI
DDT	50-29-3	354.49	EPI	0.0003401	0.00000832	EPI			0.037933	WATER9	4.4322E-06	WATER9	168600	EPI	0.0055	EPI	0.628	EPI
Dacthal	1861-32-1	331.97	EPI	0.0000891	0.00000218	EPI			0.03963	WATER9	4.6304E-06	WATER9	511.1	EPI	0.5	EPI	0.015	EPI
Dalapon	75-99-0	142.97	EPI	2.314E-06	5.66E-08	EPI	1.389	CRC89	0.060081	WATER9	9.4134E-06	WATER9	3.231	EPI	502000	EPI	0.000815	EPI
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	959.17	EPI	1.8193E-06	4.45E-08	EPI	3	IRIS	0.018924	WATER9	4.7688E-06	WATER9	276200	EPI	0.0001	EPI	0.725	EPI
Demeton	8065-48-3	258.33	EPI						0.046842	WATER9	5.4731E-06	WATER9	837.9	EPI	60	EPI	0.00761	EPI
Di(2-ethylhexyl)adipate	103-23-1	370.58	EPI	0.0000177	0.000000434	EPI	0.922	CRC89	0.017291	WATER9	4.157E-06	WATER9	36000	EPI	0.78	EPI	3.23	EPI
Diallate	2303-16-4	270.22	EPI	0.0001554	0.0000038	EPI			0.045458	WATER9	5.3114E-06	WATER9	644.3	EPI	14	EPI	0.046	EPI
Diazinon	333-41-5	304.35	EPI	4.6198E-06	0.000000113	EPI	1.1088	CRC89	0.021026	WATER9	5.2259E-06	WATER9	3034	EPI	40	EPI	0.0104	EPI
Dibromo-3-chloropropane, 1,2-	96-12-8	236.33	EPI	0.0060098	0.000147	EPI	2.093	CRC89	0.032135	WATER9	8.9048E-06	WATER9	115.8	EPI	1230	EPI	0.00685	EPI
Dibromobenzene, 1,4-	106-37-6	235.91	EPI	0.0365086	0.000893	EPI	2.261	CRC89	0.033276	WATER9	9.3369E-06	WATER9	375.3	EPI	20	EPI	0.0245	EPI
Dibromochloromethane	124-48-1	208.28	EPI	0.0320114	0.000783	EPI	2.451	CRC89	0.036636	WATER9	0.0000106	WATER9	31.82	EPI	2700	EPI	0.00289	EPI
Dibromoethane, 1,2-	106-93-4	187.86	EPI	0.026574	0.00065	EPI	2.1683	CRC89	0.043035	WATER9	0.0000104	WATER9	39.6	EPI	3910	EPI	0.00278	EPI
Dibromomethane (Methylene Bromide)	74-95-3	173.84	EPI	0.0336059	0.000822	EPI	2.4969	CRC89	0.055137	WATER9	0.0000119	WATER9	21.73	EPI	11900	EPI	0.00223	EPI
Dibutyl Phthalate	84-74-2	278.35	EPI	0.000074	0.00000181	EPI	1.0465	CRC89	0.021436	WATER9	5.3255E-06	WATER9	1157	EPI	11.2	EPI	0.042	EPI
Dibutyltin Compounds	NA																	
Dicamba	1918-00-9	221.04	EPI	8.9125E-08	2.18E-09	EPI	1.57	CRC89	0.029224	WATER9	7.8006E-06	WATER9	29.01	EPI	8310	EPI	0.00265	EPI
Dichloro-2-butene, 1,4-	764-41-0	125	EPI	0.0271464	0.000664	EPI	1.188	LANGE	0.066505	WATER9	0.00000929	WATER9	131.5	EPI	580	EPI	0.0166	EPI
Dichloro-2-butene, cis-1,4-	1476-11-5	125	EPI	0.0271464	0.000664	EPI	1.188	CRC89	0.066505	WATER9	0.00000929	WATER9	131.5	EPI	580	EPI	0.0166	EPI
Dichloro-2-butene, trans-1,4-	110-57-6	125	EPI	0.0271464	0.000664	EPI	1.183	CRC89	0.066382	WATER9	9.2665E-06	WATER9	131.5	EPI	850	EPI	0.0166	EPI
Dichloroacetic Acid	79-43-6	128.94	EPI	3.426E-07	8.38E-09	EPI	1.5634	CRC89	0.072234	WATER9	0.0000108	WATER9	2.252	EPI	1000000	EPI	0.00121	EPI
Dichlorobenzene, 1,2-	95-50-1	147	EPI	0.0784955	0.00192	EPI	1.3059	CRC89	0.05617	WATER9	8.9213E-06	WATER9	382.9	EPI	156	EPI	0.0446	EPI
Dichlorobenzene, 1,4-	106-46-7	147	EPI	0.0985282	0.00241	EPI	1.2475	CRC89	0.055043	WATER9	8.6797E-06	WATER9	375.3	EPI	81.3	EPI	0.0453	EPI
Dichlorobenzidine, 3,3'-	91-94-1	253.13	EPI	1.64E-07	4.0114E-09	SSL			0.047482	WATER9	5.5478E-06	WATER9	3190	EPI	3.1	EPI	0.0128	EPI
Dichlorobenzophenone, 4,4'-	90-98-2	251.11	EPI	0.0000437	0.00000107	EPI	1.45	CRC89	0.026393	WATER9	6.8893E-06	WATER9	2927	EPI	7.802	EPI	0.0542	EPI
Dichlorodifluoromethane	75-71-8	120.91	EPI	14.022895	0.343	EPI	1.486	PERRY	0.076029	WATER9	0.0000108	WATER9	43.89	EPI	280	EPI	0.00895	EPI
Dichloroethane, 1,1-	75-34-3	98.96	EPI	0.2297629	0.00562	EPI	1.1757	CRC89	0.083645	WATER9	0.0000106	WATER9	31.82	EPI	5040	EPI	0.00675	EPI
Dichloroethane, 1,2-	107-06-2	98.96	EPI	0.048242	0.00118	EPI	1.2454	CRC89	0.085722	WATER9	0.000011	WATER9	39.6	EPI	8600	EPI	0.0042	EPI
Dichloroethylene, 1,1-	75-35-4	96.94	EPI	1.0670482	0.0261	EPI	1.213	CRC89	0.086314	WATER9	0.000011	WATER9	31.82	EPI	2420	EPI	0.0117	EPI
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	96.94	EPI	0.1668029	0.00408	EPI	1.265	PERRY	0.087863	WATER9	0.0000112	WATER9	39.6	EPI	3500	EPI	0.011	EPI
Dichloroethylene, 1,2-cis-	156-59-2	96.94	EPI	0.1668029	0.00408	EPI	1.2837	CRC89	0.088409	WATER9	0.0000113	WATER9	39.6	EPI	6410	EPI	0.011	EPI
Dichloroethylene, 1,2-trans-	156-60-5	96.94	EPI	0.1668029	0.00408	EPI	1.2565	CRC89	0.087613	WATER9	0.0000112	WATER9	39.6	EPI	4520	EPI	0.011	EPI
Dichlorophenol, 2,4-	120-83-2	163	EPI	0.0001754	0.00000429	EPI	1.383	PERRY	0.048577	WATER9	8.6787E-06	WATER9	491.8	EPI	4500	EPI	0.0206	EPI
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	221.04	EPI	1.4473E-06	3.54E-08	EPI			0.051972	WATER9	6.0726E-06	WATER9	29.63	EPI	677	EPI	0.00664	EPI
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6	249.1	EPI	2.3998E-07	5.87E-09	EPI			0.047992	WATER9	5.6075E-06	WATER9	98.4	EPI	46	EPI	0.0139	EPI
Dichloropropane, 1,2-	78-87-5	112.99	EPI	0.1152903	0.00282	EPI	1.159	PERRY	0.07334	WATER9	9.7252E-06	WATER9	60.7	EPI	2800	EPI	0.00753	EPI
Dichloropropane, 1,3-	142-28-9	112.99	EPI	0.0399019	0.000976	EPI	1.1785	CRC89	0.073874	WATER9	9.823E-06	WATER9	72.17	EPI	2750	EPI	0.00776	EPI
Dichloropropanol, 2,3-	616-23-9	128.99	EPI	1.48E-07	3.62E-09	EPI	1.3607	CRC89	0.068017	WATER9	0.00000989	WATER9	5.568	EPI	60820	EPI	0.000983	EPI
Dichloropropene, 1,3-	542-75-6	110.97	EPI	0.1451349	0.00355	EPI	1.217	LANGE	0.076273	WATER9	0.0000101	WATER9	72.17	EPI	2800	EPI	0.00834	EPI
Dichlorvos	62-73-7	220.98	EPI	0.0000235	0.000000574	EPI	1.415	CRC89	0.027877	WATER9	7.3302E-06	WATER9	53.96	EPI	8000	EPI	0.000804	EPI
Dicyclopentadiene	77-73-6	132.21	EPI	2.5551922	0.0625	EPI	0.93	LANGE	0.055746	WATER9	7.7554E-06	WATER9	1513	EPI	13.687	EPI	0.036	EPI
Dieldrin	60-57-1	380.91	EPI	0.0004088	0.00001	EPI	1.75	CRC89	0.023287	WATER9	6.0062E-06	WATER9	20090	EPI	0.195	EPI	0.0326	EPI
Diesel Engine Exhaust	NA																	
Diethanolamine	111-42-2	105.14	EPI	1.5822E-09	3.87E-11	EPI	1.0966	CRC89	0.076805	WATER9	9.8229E-06	WATER9	1	EPI	1000000	EPI	0.0000451	EPI
Diethyl Phthalate	84-66-2	222.24	EPI	0.0000249	0.00000061	EPI	1.232	CRC89	0.026074	WATER9	6.7227E-06	WATER9	104.9	EPI	1080	EPI	0.0036	EPI
Diethylene Glycol Monobutyl Ether	112-34-5	162.23	EPI	2.9436E-07	7.2E-09	EPI	0.9553	CRC89	0.041438	WATER9	6.9707E-06	WATER9	10	EPI	1000000	EPI	0.000454	EPI
Diethylene Glycol Monoethyl Ether	111-90-0	134.18	EPI	9.1169E-07	2.23E-08	EPI	0.9885	CRC89	0.056241	WATER9	7.9734E-06	WATER9	1	EPI	1000000	EPI	0.000121	EPI
Diethylformamide	617-84-5	101.15	EPI	5.3148E-06	0.00000013	EPI	0.908	CRC89	0.073301	WATER9	8.9773E-06	WATER9	2.06	EPI	1000000	EPI	0.000457	EPI
Diethylstilbestrol	56-53-1	268.36	EPI	2.371E-10	5.8E-12	EPI			0.045668	WATER9	5.3359E-06	WATER9	274100	EPI	12	EPI	0.114	EPI
Difenzoquat	43222-48-6	360.43	EPI						0.037515	WATER9	4.3833E-06	WATER9	78380	EPI	817000	EPI	0.0000402	EPI
Diflubenzuron	35367-38-5	310.69	EPI	1.8806E-07	4.6E-09	EPI			0.041419	WATER9	4.8395E-06	WATER9	463.2	EPI	0.08	EPI	0.0107	EPI
Difluoroethane, 1,1-	75-37-6	66.05	EPI	0.8299264	0.0203	EPI	0.896	CRC89	0.102316	WATER9	0.0000115	WATER9	31.82	EPI	3200	EPI	0.0021	EPI
Dihydrosafrole	94-58-6	164.21	EPI	6.7457073	0.165	EPI			0.063361	WATER9	7.4032E-06	WATER9	207.2	EPI	5.7727	EPI	0.0452	EPI
Diisopropyl Ether	108-20-3	102.18	EPI	0.1046607	0.00256	EPI	0.7192	CRC89	0.065423	WATER9	7.7582E-06	WATER9	22.79	EPI	8800	EPI	0.00428	EPI
Diisopropyl Methylphosphonate	1445-75-6	180.19	EPI	0.0017907	0.0000438	EPI			0.059557	WATER9	6.9588E-06	WATER9	42.2	EPI	1500	EPI	0.000738	EPI
Dimethipin	55290-64-7	210.26	EPI	9.403E-10	2.3E-11	EPI			0.053734	WATER9	6.2784E-06	WATER9	10	EPI	4600	EPI	0.0000798	EPI
Dimethoate	60-51-5	229.25	EPI	9.9346E-09	2.43E-10	EPI	1.277	CRC89	0.026086	WATER9	6.7422E-06	WATER9	12.77	EPI	23300	EPI	0.000267	EPI
Dimethoxybenzidine, 3,3'-	119-90-4	244.3	EPI	1.9052E-09	4.66E-11	EPI			0.048619	WATER9	5.6807E-06	WATER9	508.8	EPI	60	EPI	0.00106	EPI
Dimethyl methylphosphonate	756-79-6	124.08	EPI	0.0000511	0.00000125	EPI	1.1684	CRC89	0.06658	WATER9	9.2386E-06	WATER9	5.407	EPI	1000000	EPI	0.000124	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Dimethylamino azobenzene [p-]	60-11-7	225.3	EPI	9.5666E-06	0.000000234	EPI			0.051315	WATER9	5.9958E-06	WATER9	2028	EPI	0.23	EPI	0.0943	EPI
Dimethylaniline HCl, 2,4-	21436-96-4	157.64	EPI	8.79E-12	2.15E-13	EPI			0.065109	WATER9	7.6075E-06	WATER9	351.9	EPI	150.28	EPI	0.0000202	EPI
Dimethylaniline, 2,4-	95-68-1	121.18	EPI	0.0001022	0.0000025	EPI	0.9723	CRC89	0.063025	WATER9	8.3925E-06	WATER9	184.5	EPI	2175.5	EPI	0.00428	EPI
Dimethylaniline, N,N-	121-69-7	121.18	EPI	0.0023222	0.0000568	EPI	0.9557	CRC89	0.062541	WATER9	8.3063E-06	WATER9	78.67	EPI	1450	EPI	0.0112	EPI
Dimethylbenzidine, 3,3'-	119-93-7	212.3	EPI	3.3115E-09	8.1E-11	EPI			0.053389	WATER9	6.2381E-06	WATER9	3190	EPI	1300	EPI	0.00362	EPI
Dimethylformamide	68-12-2	73.1	EPI	3.0213E-06	7.39E-08	EPI	0.9445	CRC89	0.09718	WATER9	0.0000112	WATER9	1	EPI	1000000	EPI	0.00013	EPI
Dimethylhydrazine, 1,1-	57-14-7	60.1	EPI	2.8414E-06	6.95E-08	EPI	0.791	CRC89	0.103785	WATER9	0.0000113	WATER9	11.95	EPI	1000000	EPI	0.0000727	RAGSE
Dimethylhydrazine, 1,2-	540-73-8	60.1	EPI	2.8414E-06	6.95E-08	EPI	0.8274	CRC89	0.105769	WATER9	0.0000116	WATER9	14.87	EPI	1000000	EPI	0.000317	EPI
Dimethylphenol, 2,4-	105-67-9	122.17	EPI	0.0000389	0.000000951	EPI	0.965	CRC89	0.062245	WATER9	8.314E-06	WATER9	491.8	EPI	7870	EPI	0.0109	EPI
Dimethylphenol, 2,6-	576-26-1	122.17	EPI	0.0002719	0.00000665	EPI			0.077169	WATER9	9.0166E-06	WATER9	501.9	EPI	6050	EPI	0.012	EPI
Dimethylphenol, 3,4-	95-65-8	122.17	EPI	0.000017	0.000000415	EPI	0.983	CRC89	0.062762	WATER9	8.4067E-06	WATER9	491.8	EPI	4760	EPI	0.0098	EPI
Dimethylterephthalate	120-61-6	194.19	EPI	0.0054783	0.000134	EPI	1.075	CRC89	0.028533	WATER9	6.7171E-06	WATER9	30.96	EPI	19	EPI	0.00399	EPI
Dimethylvinylchloride	513-37-1	90.55	EPI	3.311529	0.081	EPI	0.9186	CRC89	0.081174	WATER9	9.6608E-06	WATER9	60.7	EPI	1000	EPI	0.0253	EPI
Dinitro-o-cresol, 4,6-	534-52-1	198.14	EPI	0.0000572	0.0000014	EPI			0.055904	WATER9	6.5319E-06	WATER9	754.4	EPI	198	EPI	0.00315	EPI
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	266.26	EPI	1.3818E-09	3.38E-11	EPI			0.045907	WATER9	5.3639E-06	WATER9	16540	EPI	15	EPI	0.0275	EPI
Dinitrobenzene, 1,2-	528-29-0	168.11	EPI	2.1791E-06	5.33E-08	EPI	1.3119	CRC89	0.044718	WATER9	8.2538E-06	WATER9	358.8	EPI	133	EPI	0.00237	EPI
Dinitrobenzene, 1,3-	99-65-0	168.11	EPI	2.0033E-06	0.000000049	EPI	1.5751	CRC89	0.048499	WATER9	9.2109E-06	WATER9	351.6	EPI	533	EPI	0.00174	EPI
Dinitrobenzene, 1,4-	100-25-4	168.11	EPI	0.0000151	0.00000037	EPI	1.625	CRC89	0.049167	WATER9	9.3849E-06	WATER9	351.6	EPI	69	EPI	0.00167	EPI
Dinitrophenol, 2,4-	51-28-5	184.11	EPI	3.5159E-06	0.000000086	EPI	1.683	CRC89	0.04067	WATER9	9.0756E-06	WATER9	460.8	EPI	2790	EPI	0.00187	EPI
Dinitrotoluene Mixture, 2,4/2,6-	NA	182.14	EPI	0.0000162	0.000000397	EPI			0.059131	WATER9	6.909E-06	WATER9	587.4	EPI	270	EPI	0.00416	EPI
Dinitrotoluene, 2,4-	121-14-2	182.14	EPI	2.2077E-06	0.000000054	EPI	1.3208	CRC89	0.037512	WATER9	7.8982E-06	WATER9	575.6	EPI	200	EPI	0.00308	EPI
Dinitrotoluene, 2,6-	606-20-2	182.14	EPI	0.0000305	0.000000747	EPI	1.2833	CRC89	0.037026	WATER9	7.7629E-06	WATER9	587.4	EPI	182	SSL	0.0037	EPI
Dinitrotoluene, 2-Amino-4,6-	35572-78-2	197.15	EPI	6.6231E-09	1.62E-10	EPI			0.056091	WATER9	6.5537E-06	WATER9	283	EPI	319.49	EPI	0.00204	EPI
Dinitrotoluene, 4-Amino-2,6-	19406-51-0	197.15	EPI	6.6231E-09	1.62E-10	EPI			0.056091	WATER9	6.5537E-06	WATER9	283	EPI	319.49	EPI	0.00204	EPI
Dinitrotoluene, Technical grade	25321-14-6	182.14	EPI	0.0000162	0.000000397	EPI			0.059131	WATER9	6.909E-06	WATER9	587.4	EPI	270	EPI	0.00416	EPI
Dinoseb	88-85-7	240.22	EPI	0.0000186	0.000000456	EPI	1.265	CRC89	0.025346	WATER9	6.5187E-06	WATER9	4294	EPI	52	EPI	0.0163	EPI
Dioxane, 1,4-	123-91-1	88.11	EPI	0.0001962	0.0000048	EPI	1.0337	CRC89	0.087372	WATER9	0.0000105	WATER9	2.633	EPI	1000000	EPI	0.000332	EPI
Dioxins																		
~Hexachlorodibenzo-p-dioxin, Mixture	NA	390.87	EPI	0.000233	0.0000057	EPI			0.042683	WATER9	4.1527E-06	WATER9	695200	EPI	0.000004	EPI	2.86	EPI
~TCDD, 2,3,7,8-	1746-01-6	321.98	EPI	0.0020442	0.00005	EPI			0.047028	WATER9	4.7257E-06	WATER9	249100	EPI	0.0002	EPI	0.808	EPI
Diphenamid	957-51-7	239.32	EPI	1.4841E-09	3.63E-11	EPI	1.17	CRC89	0.024483	WATER9	6.2344E-06	WATER9	4798	EPI	260	EPI	0.00563	EPI
Diphenyl Sulfone	127-63-9	218.27	EPI	0.0000102	0.000000249	EPI	1.252	CRC89	0.026518	WATER9	6.8618E-06	WATER9	1109	EPI	9.4191	EPI	0.00367	EPI
Diphenylamine	122-39-4	169.23	EPI	0.00011	0.00000269	EPI	1.158	CRC89	0.041706	WATER9	7.628E-06	WATER9	825.8	EPI	53	EPI	0.0373	EPI
Diphenylhydrazine, 1,2-	122-66-7	184.24	EPI	0.0000195	0.000000478	EPI	1.158	CRC89	0.034312	WATER9	7.2488E-06	WATER9	1505	EPI	221	EPI	0.013	EPI
Diquat	85-00-7	344.05	EPI	5.805E-12	1.42E-13	EPI	1.24	CRC89	0.02081	WATER9	5.1922E-06	WATER9	9272	EPI	708000	EPI	2.44E-07	EPI
Direct Black 38	1937-37-7	737.77	EPI	3.365E-38	8.23E-40	EPI			0.023271	WATER9	2.719E-06	WATER9	242000000	EPI	55.937	EPI	0.000205	EPI
Direct Blue 6	2602-46-2	821.67	EPI	6.705E-42	1.64E-43	EPI			0.021658	WATER9	2.5306E-06	WATER9	790800000	EPI	8.2167E-07	EPI	1.73E-09	EPI
Direct Brown 95	16071-86-6	760.11	EPI						0.022812	WATER9	2.6654E-06	WATER9	6985000	EPI	9.7133E-07	EPI	3.87E-12	EPI
Disulfoton	298-04-4	274.39	EPI	0.0000883	0.00000216	EPI	1.144	CRC89	0.022543	WATER9	5.6664E-06	WATER9	837.9	EPI	16.3	EPI	0.0212	EPI
Dithiane, 1,4-	505-29-3	120.23	EPI	0.0017171	0.000042	EPI			0.077997	WATER9	9.1133E-06	WATER9	145.8	EPI	3000	EPI	0.00108	EPI
Diuron	330-54-1	233.1	EPI	2.0605E-08	5.04E-10	EPI			0.050164	WATER9	5.8613E-06	WATER9	109.1	EPI	42	EPI	0.00466	EPI
Dodine	2439-10-3	287.45	EPI	3.6836E-09	9.01E-11	EPI			0.043623	WATER9	5.097E-06	WATER9	2482	EPI	630	EPI	0.000222	EPI
EPTC	759-94-4	189.32	EPI	0.00065	0.0000159	EPI	0.9546	CRC89	0.029126	WATER9	6.3511E-06	WATER9	164.1	EPI	375	EPI	0.0184	EPI
Endosulfan	115-29-7	406.92	EPI	0.0026574	0.000065	EPI	1.745	CRC89	0.022485	WATER9	5.7629E-06	WATER9	6761	EPI	0.325	EPI	0.00286	EPI
Endothall	145-73-3	186.17	EPI	1.574E-14	3.85E-16	EPI	1.431	CRC89	0.036747	WATER9	8.1792E-06	WATER9	19.41	EPI	100000	EPI	0.00263	EPI
Endrin	72-20-8	380.91	EPI	0.0004088	0.00001	EPI			0.036158	WATER9	4.2248E-06	WATER9	20090	EPI	0.25	EPI	0.0326	EPI
Epichlorohydrin	106-89-8	92.53	EPI	0.0012428	0.0000304	EPI	1.183	PERRY	0.088865	WATER9	0.0000111	WATER9	9.907	EPI	65900	EPI	0.000944	EPI
Epoxybutane, 1,2-	106-88-7	72.11	EPI	0.007359	0.00018	EPI	0.8297	CRC89	0.092894	WATER9	0.0000104	WATER9	9.907	EPI	95000	EPI	0.00231	EPI
Ethephon	16672-87-0	144.5	EPI	2.33E-10	5.7E-12	EPI	1.2	CRC89	0.055477	WATER9	8.5676E-06	WATER9	5.028	EPI	1000000	EPI	0.000173	EPI
Ethion	563-12-2	384.46	EPI	0.0000155	0.000000379	EPI	1.22	CRC89	0.019478	WATER9	4.8104E-06	WATER9	882	EPI	2	EPI	0.0255	EPI
Ethoxyethanol Acetate, 2-	111-15-9	132.16	EPI	0.0001308	0.0000032	EPI	0.974	CRC89	0.05695	WATER9	7.9753E-06	WATER9	4.542	EPI	247000	EPI	0.0007	EPI
Ethoxyethanol, 2-	110-80-5	90.12	EPI	0.0000192	0.00000047	EPI	0.9253	CRC89	0.081756	WATER9	9.7308E-06	WATER9	1	EPI	1000000	EPI	0.0003	EPI
Ethyl Acetate	141-78-6	88.11	EPI	0.0054783	0.000134	EPI	0.9003	CRC89	0.082314	WATER9	9.7026E-06	WATER9	5.583	EPI	80000	EPI	0.00153	EPI
Ethyl Acrylate	140-88-5	100.12	EPI	0.0138594	0.000339	EPI	0.9234	CRC89	0.074539	WATER9	9.1242E-06	WATER9	10.65	EPI	15000	EPI	0.00324	EPI
Ethyl Chloride	75-00-3	64.52	EPI	0.4538021	0.0111	EPI	0.8902	CRC89	0.103754	WATER9	0.0000116	WATER9	21.73	EPI	6710	EPI	0.00607	EPI
Ethyl Ether	60-29-7	74.12	EPI	0.0502862	0.00123	EPI	0.7138	CRC89	0.085248	WATER9	9.3639E-06	WATER9	9.699	EPI	60400	EPI	0.00235	EPI
Ethyl Methacrylate	97-63-2	114.15	EPI	0.023426	0.000573	EPI	0.9135	CRC89	0.065344	WATER9	8.3794E-06	WATER9	16.66	EPI	5400	EPI	0.00698	EPI
Ethyl-p-nitrophenyl Phosphonate	2104-64-5	323.31	EPI	0.0000182	0.000000444	EPI	1.27	CRC89	0.021748	WATER9	5.4674E-06	WATER9	15470	EPI	3.11	EPI	0.0361	EPI
Ethylbenzene	100-41-4	106.17	EPI	0.3221586	0.00788	EPI	0.8626	CRC89	0.068465	WATER9	8.4558E-06	WATER9	446.1	EPI	169	EPI	0.0493	EPI
Ethylene Cyanohydrin	109-78-4	71.08	EPI	3.0662E-07	7.5E-09	EPI	1.0404	CRC89	0.10331	WATER9	0.000012	WATER9	1	EPI	1000000	EPI	0.000148	EPI
Ethylene Diamine	107-15-3	60.1	EPI	7.0728E-08	1.73E-09	EPI	0.8979	CRC89	0.109445	WATER9	0.0000122	WATER9	14.87	EPI	1000000	EPI	0.0000318	EPI
Ethylene Glycol	107-21-1	62.07	EPI	2.453E-06	0.00000006	EPI	1.1135	CRC89	0.116924	WATER9	0.0000136	WATER9	1	EPI	1000000	EPI	0.0000877	EPI
Ethylene Glycol Monobutyl Ether	111-76-2	118.18	EPI	0.0000654	0.0000016	EPI	0.9015	CRC89	0.062619	WATER9	8.1419E-06	WATER9	2.823	EPI	1000000	EPI	0.00121	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Ethylene Oxide	75-21-8	44.05	EPI	0.0060507	0.000148	EPI	0.8821	CRC89	0.133972	WATER9	0.0000145	WATER9	3.237	EPI	1000000	EPI	0.00056	EPI
Ethylene Thiourea	96-45-7	102.15	EPI	0.0000137	0.000000336	EPI			0.086948	WATER9	0.0000102	WATER9	12.97	EPI	20000	EPI	0.000152	EPI
Ethyleneimine	151-56-4	43.07	EPI	0.0004947	0.0000121	EPI	0.832	CRC89	0.132827	WATER9	0.0000142	WATER9	9.043	EPI	1000000	EPI	0.000581	EPI
Ethylphthalyl Ethyl Glycolate	84-72-0	280.28	EPI	3.1603E-08	7.73E-10	EPI			0.044364	WATER9	5.1835E-06	WATER9	1019	EPI	992.56	EPI	0.00119	EPI
Express	101200-48-0	395.39	EPI	4.17E-12	1.02E-13	EPI			0.03527	WATER9	4.121E-06	WATER9	94.69	EPI	50	EPI	0.000468	EPI
Fenamiphos	22224-92-6	303.36	EPI	4.9469E-08	1.21E-09	EPI	1.15	CRC89	0.021437	WATER9	5.352E-06	WATER9	398	EPI	329	EPI	0.00436	EPI
Fenpropathrin	39515-41-8	349.43	EPI	0.0003123	0.00000764	EPI			0.038298	WATER9	4.4749E-06	WATER9	22490	EPI	0.33	EPI	0.167	EPI
Fluometuron	2164-17-2	232.21	EPI	1.067E-07	2.61E-09	EPI			0.050292	WATER9	5.8762E-06	WATER9	285.3	EPI	110	EPI	0.00316	EPI
Fluoride	16984-48-8	38	EPI												1.69	EPI	0.001	RAGSE
Fluorine (Soluble Fluoride)	7782-41-4	38	EPI				1.553	CRC89							1.69	EPI	0.001	RAGSE
Fluridone	59756-60-4	329.32	EPI	3.3115E-07	8.1E-09	EPI			0.039842	WATER9	4.6552E-06	WATER9	56770	EPI	12	EPI	0.0028	EPI
Flurprimidol	56425-91-3	312.29	EPI	5.3557E-08	1.31E-09	EPI			0.041278	WATER9	4.823E-06	WATER9	2189	EPI	114	EPI	0.00459	EPI
Flutolanil	66332-96-5	323.32	EPI	1.3001E-07	3.18E-09	EPI			0.040333	WATER9	4.7126E-06	WATER9	2558	EPI	6.53	EPI	0.00691	EPI
Fluvalinate	69409-94-5	502.92	EPI	5.928E-07	1.45E-08	EPI			0.030044	WATER9	3.5104E-06	WATER9	730000	EPI	0.005	EPI	0.0792	EPI
Folpet	133-07-3	296.56	EPI	3.1316E-06	7.66E-08	EPI			0.042725	WATER9	4.992E-06	WATER9	17.7	EPI	0.8	EPI	0.00266	EPI
Fomesafen	72178-02-0	438.76	EPI	3.078E-11	7.53E-13	EPI	1.28	CRC89	0.018607	WATER9	4.5736E-06	WATER9	1546	EPI	50	EPI	0.000457	EPI
Fonofos	944-22-9	246.32	EPI	0.0002854	0.00000698	EPI	1.16	CRC89	0.024017	WATER9	6.096E-06	WATER9	855.8	EPI	15.7	EPI	0.027	EPI
Formaldehyde	50-00-0	30.03	EPI	0.0000138	0.000000337	EPI	0.815	CRC89	0.167073	WATER9	0.0000174	WATER9	1	EPI	400000	EPI	0.00182	EPI
Formic Acid	64-18-6	46.03	EPI	6.8275E-06	0.000000167	EPI	1.22	CRC89	0.147862	WATER9	0.0000172	WATER9	1	EPI	1000000	EPI	0.000378	EPI
Fosetyl-AL	39148-24-8	354.11	EPI						0.03796	WATER9	4.4353E-06	WATER9	6485	EPI	111000	EPI	0.00000041	EPI
Furans																		
~Dibenzofuran	132-64-9	168.2	EPI	0.0087081	0.000213	EPI	1.0886	CRC89	0.04105	WATER9	7.3773E-06	WATER9	9161	EPI	3.1	EPI	0.0975	EPI
~Furan	110-00-9	68.08	EPI	0.2207686	0.0054	EPI	0.9514	CRC89	0.102673	WATER9	0.0000117	WATER9	79.99	EPI	10000	EPI	0.00505	EPI
~Tetrahydrofuran	109-99-9	72.11	EPI	0.0028823	0.0000705	EPI	0.8833	CRC89	0.095413	WATER9	0.0000108	WATER9	10.75	EPI	1000000	EPI	0.00125	EPI
Furazolidone	67-45-8	225.16	EPI	1.3328E-09	3.26E-11	EPI			0.051337	WATER9	5.9983E-06	WATER9	858.4	EPI	40	EPI	0.0000803	EPI
Furfural	98-01-1	96.09	EPI	0.0001541	0.00000377	EPI	1.1594	CRC89	0.085318	WATER9	0.0000107	WATER9	6.083	EPI	74100	EPI	0.000848	EPI
Furium	531-82-8	253.23	EPI	5.437E-14	1.33E-15	EPI			0.047469	WATER9	5.5464E-06	WATER9	577.6	EPI	4205.3	EPI	0.000935	EPI
Furmecyclox	60568-05-0	251.33	EPI	2.8168E-07	6.89E-09	EPI			0.047708	WATER9	5.5743E-06	WATER9	429	EPI	0.3	EPI	0.0499	EPI
Glufosinate, Ammonium	77182-82-2	198.16	EPI	1.034E-22	2.53E-24	EPI			0.0559	WATER9	6.5314E-06	WATER9	10	EPI	1370000	EPI	3.42E-08	EPI
Glutaraldehyde	111-30-8	100.12	EPI	9.7711E-07	2.39E-08	EPI			0.08812	WATER9	0.0000103	WATER9	1	EPI	709980	EPI	0.000325	EPI
Glycidyl	765-34-4	72.06	EPI	0.0000321	0.000000784	EPI	1.1403	CRC89	0.106251	WATER9	0.0000126	WATER9	1	EPI	1000000	EPI	0.000516	EPI
Glyphosate	1071-83-6	169.07	EPI	8.585E-11	2.1E-12	EPI			0.062141	WATER9	7.2606E-06	WATER9	2100	ARS	10500	EPI	4.54E-08	EPI
Goal	42874-03-3	361.71	EPI	0.0000335	0.00000082	EPI	1.35	CRC89	0.021124	WATER9	5.3022E-06	WATER9	39900	EPI	0.116	EPI	0.0204	EPI
Guthion	86-50-0	317.32	EPI	9.7711E-07	2.39E-08	EPI	1.44	CRC89	0.023317	WATER9	5.962E-06	WATER9	51.93	EPI	20.9	EPI	0.00175	EPI
Haloxyfop, Methyl	69806-40-2	375.73	EPI	0.000013	0.000000319	EPI			0.03649	WATER9	4.2635E-06	WATER9	5454	EPI	9.3	EPI	0.006	EPI
Harmony	79277-27-3	387.39	EPI	1.668E-12	4.08E-14	EPI			0.035754	WATER9	4.1775E-06	WATER9	50.76	EPI	2240	EPI	0.000114	EPI
Heptachlor	76-44-8	373.32	EPI	0.0120196	0.000294	EPI	1.57	CRC89	0.022344	WATER9	5.6959E-06	WATER9	41260	EPI	0.18	EPI	0.143	EPI
Heptachlor Epoxide	1024-57-3	389.32	EPI	0.0008585	0.000021	EPI			0.035636	WATER9	4.1637E-06	WATER9	10110	EPI	0.2	EPI	0.0209	EPI
Hexabromobenzene	87-82-1	551.49	EPI	0.0011488	0.0000281	EPI			0.028253	WATER9	3.3011E-06	WATER9	2807	EPI	0.00016	EPI	0.0136	EPI
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2														0.0009	IRIS		
Hexachlorobenzene	118-74-1	284.78	EPI	0.0695012	0.0017	EPI	2.044	CRC89	0.028975	WATER9	7.8497E-06	WATER9	6195	EPI	0.0062	EPI	0.254	EPI
Hexachlorobutadiene	87-68-3	260.76	EPI	0.4210957	0.0103	EPI	1.556	CRC89	0.026745	WATER9	7.0264E-06	WATER9	845.2	EPI	3.2	EPI	0.081	EPI
Hexachlorocyclohexane, Alpha-	319-84-6	290.83	EPI	0.0002101	0.00000514	EPI			0.043284	WATER9	5.0574E-06	WATER9	2807	EPI	2	EPI	0.0206	EPI
Hexachlorocyclohexane, Beta-	319-85-7	290.83	EPI	0.0002101	0.00000514	EPI	1.89	CRC89	0.027667	WATER9	7.3955E-06	WATER9	2807	EPI	0.24	EPI	0.0206	EPI
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	290.83	EPI	0.0002101	0.00000514	EPI			0.043284	WATER9	5.0574E-06	WATER9	2807	EPI	7.3	EPI	0.0206	EPI
Hexachlorocyclohexane, Technical	608-73-1	290.83	EPI	0.0002101	0.00000514	EPI			0.043284	WATER9	5.0574E-06	WATER9	2807	EPI	8	EPI	0.0206	EPI
Hexachlorocyclopentadiene	77-47-4	272.77	EPI	1.103843	0.027	EPI	1.7019	CRC89	0.027238	WATER9	7.217E-06	WATER9	1404	EPI	1.8	EPI	0.103	EPI
Hexachloroethane	67-72-1	236.74	EPI	0.1590352	0.00389	EPI	2.091	CRC89	0.032094	WATER9	8.8904E-06	WATER9	196.8	EPI	50	EPI	0.0415	EPI
Hexachlorophene	70-30-4	406.91	EPI	2.24E-11	5.48E-13	EPI			0.034601	WATER9	4.0428E-06	WATER9	668600	EPI	140	EPI	0.836	EPI
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	222.12	EPI	8.217E-10	2.01E-11	EPI	1.82	CRC89	0.031154	WATER9	8.4989E-06	WATER9	89.07	EPI	59.7	EPI	0.000336	EPI
Hexamethylene Diisocyanate, 1,6-	822-06-0	168.2	EPI	0.0019624	0.000048	EPI	1.0528	CRC89	0.040426	WATER9	7.2308E-06	WATER9	4818	EPI	179.03	EPI	0.0237	EPI
Hexamethylphosphoramide	680-31-9	179.2	EPI	2.92E-10	7.13E-12	EPI	1.03	CRC89	0.034837	WATER9	6.8702E-06	WATER9	10	EPI	1000000	EPI	0.000237	EPI
Hexane, N-	110-54-3	86.18	EPI	73.589534	1.8	EPI	0.6606	CRC89	0.073106	WATER9	8.1657E-06	WATER9	131.5	EPI	9.5	EPI	0.201	EPI
Hexanedioic Acid	124-04-9	146.14	EPI	1.926E-10	4.71E-12	EPI	1.36	CRC89	0.057682	WATER9	9.1735E-06	WATER9	24.34	EPI	30800	EPI	0.000268	EPI
Hexanone, 2-	591-78-6	100.16	EPI	0.0038103	0.0000932	EPI	0.8113	CRC89	0.070356	WATER9	8.4404E-06	WATER9	14.98	EPI	17200	EPI	0.00355	EPI
Hexazinone	51235-04-2	252.32	EPI	9.24E-11	2.26E-12	EPI	1.25	CRC89	0.024566	WATER9	6.2842E-06	WATER9	129.4	EPI	33000	EPI	0.00102	EPI
Hydrazine	302-01-2	32.05	EPI				1.0036	CRC89							1000000	EPI	0.0000436	RAGSE
Hydrazine Sulfate	10034-93-2	128.1	EPI				1.378	CRC89							30550	PERRY	0.001	RAGSE
Hydrogen Chloride	7647-01-0	35.45	EPI				1.49	CRC89									0.001	RAGSE
Hydrogen Fluoride	7664-39-3	20.01	EPI				0.818	CRC89									0.001	RAGSE
Hydrogen Sulfide	7783-06-4	34.08	EPI				1.393	CRC89							4370000	PERRY	0.001	RAGSE
Hydroquinone	123-31-9	110.11	EPI	1.9338E-09	4.73E-11	EPI	1.33	CRC89	0.079843	WATER9	0.0000107	WATER9	240.5	EPI	72000	EPI	0.000931	EPI
Imazalil	35554-44-0	297.19	EPI	1.0589E-07	2.59E-09	EPI	1.243	CRC89	0.022493	WATER9	5.6772E-06	WATER9	8495	EPI	180	EPI	0.0116	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Imazaquin	81335-37-7	311.34	EPI	2.825E-16	6.91E-18	EPI			0.041362	WATER9	4.8328E-06	WATER9	2386	EPI	90	EPI	0.000483	EPI
Iodine	7553-56-2	253.81	EPI				4.933	CRC89							330	EPI	0.001	RAGSE
Iprodione	36734-19-7	330.17	EPI	1.2756E-07	3.12E-09	EPI			0.039774	WATER9	4.6472E-06	WATER9	52.52	EPI	13.9	EPI	0.00217	EPI
Iron	7439-89-6	55.85	EPI				7.87	CRC89									0.001	RAGSE
Isobutyl Alcohol	78-83-1	74.12	EPI	0.0003998	0.00000978	EPI	0.8018	CRC89	0.089671	WATER9	0.00001	WATER9	2.919	EPI	85000	EPI	0.00192	EPI
Isophorone	78-59-1	138.21	EPI	0.0002715	0.00000664	EPI	0.9255	CRC89	0.052505	WATER9	7.5296E-06	WATER9	65.15	EPI	12000	EPI	0.00354	EPI
Isopropalin	33820-53-0	309.37	EPI	0.004538	0.000111	EPI			0.041537	WATER9	4.8533E-06	WATER9	11430	EPI	0.11	EPI	0.207	EPI
Isopropanol	67-63-0	60.1	EPI	0.0003312	0.0000081	EPI	0.7809	CRC89	0.103223	WATER9	0.0000112	WATER9	1.53	EPI	1000000	EPI	0.000778	EPI
Isopropyl Methyl Phosphonic Acid	1832-54-8	138.1	EPI	2.8128E-07	6.88E-09	EPI			0.071114	WATER9	8.3092E-06	WATER9	7.707	EPI	1000000	EPI	0.000396	EPI
Isoxaben	82558-50-7	332.4	EPI	5.1922E-08	1.27E-09	EPI			0.039596	WATER9	4.6264E-06	WATER9	1262	EPI	1.42	EPI	0.00887	EPI
JP-7	NA																	
Kerb	23950-58-5	256.13	EPI	3.9943E-07	9.77E-09	EPI			0.04711	WATER9	5.5044E-06	WATER9	404.9	EPI	15	EPI	0.0109	EPI
Lactofen	77501-63-4	461.78	EPI	0.0000193	0.000000472	EPI			0.031803	WATER9	3.7159E-06	WATER9	23030	EPI	0.1	EPI	0.00631	EPI
Lead Compounds																		
~Lead acetate	301-04-2	325.29	EPI				3.25	CRC89	0.033366	WATER9	9.5728E-06	WATER9	1	EPI	443000	CRC89	0.0000208	EPI
~Lead and Compounds	7439-92-1	207.2	EPI				11.3	CRC89									0.0001	RAGSE
~Lead subacetate	1335-32-6	805.7	EPI						0.021943	WATER9	2.5639E-06	WATER9	10.37	EPI	63000	CRC89	1.03E-10	EPI
~Tetraethyl Lead	78-00-2	323.45	EPI	23.221586	0.568	EPI	1.653	CRC89	0.02464	WATER9	6.4025E-06	WATER9	647.9	EPI	0.29	EPI	0.0137	EPI
Linuron	330-55-2	249.1	EPI	2.5552E-07	6.25E-09	EPI			0.047992	WATER9	5.6075E-06	WATER9	339.8	EPI	75	EPI	0.00839	EPI
Lithium	7439-93-2	6.94	EPI				0.534	CRC89									0.001	RAGSE
Londax	83055-99-6	410.4	EPI	1.545E-13	3.78E-15	EPI			0.034405	WATER9	4.0199E-06	WATER9	27.76	EPI	120	EPI	0.000219	EPI
MCPA	94-74-6	200.62	EPI	5.4374E-08	1.33E-09	EPI			0.055442	WATER9	6.4779E-06	WATER9	29.63	EPI	630	EPI	0.0169	EPI
MCPB	94-81-5	228.68	EPI	1.1079E-07	2.71E-09	EPI			0.050808	WATER9	5.9366E-06	WATER9	98.4	EPI	48	EPI	0.0173	EPI
MCPP	93-65-2	214.65	EPI	3.6631E-08	8.96E-10	EPI			0.052999	WATER9	6.1925E-06	WATER9	48.51	EPI	620	EPI	0.0131	EPI
Malathion	121-75-5	330.35	EPI	1.9992E-07	4.89E-09	EPI	1.2076	CRC89	0.020988	WATER9	5.2365E-06	WATER9	31.27	EPI	143	EPI	0.000812	EPI
Maleic Anhydride	108-31-6	98.06	EPI	0.0001607	0.00000393	EPI	1.314	CRC89	0.088395	WATER9	0.0000114	WATER9	1	EPI	163000	PERRY	0.00525	EPI
Maleic Hydrazide	123-33-1	112.09	EPI	1.0834E-09	2.65E-11	EPI			0.081729	WATER9	9.5494E-06	WATER9	3.303	EPI	4510	EPI	0.000102	EPI
Malononitrile	109-77-3	66.06	EPI	5.3557E-06	0.000000131	EPI	1.191	CRC89	0.115073	WATER9	0.0000136	WATER9	3.334	EPI	133000	EPI	0.000266	EPI
Mancozeb	8018-01-7	212.36	EPI	0.0000231	0.000000564	EPI			0.053379	WATER9	6.2369E-06	WATER9	607.6	EPI	1000000	EPI	0.000771	EPI
Maneb	12427-38-2	212.36	EPI	0.0000231	0.000000564	EPI			0.053379	WATER9	6.2369E-06	WATER9	607.6	EPI	1000000	EPI	0.000771	EPI
Manganese (Diet)	7439-96-5	54.94	EPI				7.3	CRC89									0.001	RAGSE
Manganese (Non-diet)	7439-96-5	54.94	EPI				7.3	CRC89									0.001	RAGSE
Mephosfolan	950-10-7	269.32	EPI	4.8651E-09	1.19E-10	EPI			0.045559	WATER9	5.3232E-06	WATER9	636.3	EPI	57	EPI	0.000237	EPI
Mepiquat Chloride	24307-26-4	149.67	EPI	1.762E-10	4.31E-12	EPI			0.067401	WATER9	7.8752E-06	WATER9	66.16	EPI	500000	EPI	0.00000303	EPI
Mercury Compounds																		
~Mercuric Chloride (and other Mercury salts)	7487-94-7	271.5	EPI				5.6	CRC89							69000	EPI	0.001	RAGSE
~Mercury (elemental)	7439-97-6	200.59	EPI	0.467	0.0114228	SSL	13.5336	CRC89	0.0307	SSL	0.0000063	SSL			0.06	EPI	0.001	RAGSE
~Methyl Mercury	22967-92-6	215.63	EPI														0.001	RAGSE
~Phenylmercuric Acetate	62-38-4	336.74	EPI	2.314E-08	5.66E-10	EPI			0.039255	WATER9	4.5866E-06	WATER9	56.44	EPI	4370	EPI	0.0000599	EPI
Merphos	150-50-5	298.5	EPI	0.000928	0.0000227	EPI	1.02	CRC89	0.0204	WATER9	5.0288E-06	WATER9	48970	EPI	0.0009971	EPI	4.15	EPI
Merphos Oxide	78-48-8	314.5	EPI	0.000012	0.000000294	EPI	1.057	CRC89	0.02019	WATER9	4.979E-06	WATER9	2350	EPI	2.3	EPI	0.165	EPI
Metalaxyl	57837-19-1	279.34	EPI	1.2061E-07	2.95E-09	EPI			0.044463	WATER9	5.1951E-06	WATER9	38.57	EPI	8400	EPI	0.00058	EPI
Methacrylonitrile	126-98-7	67.09	EPI	0.0100981	0.000247	EPI	0.8001	CRC89	0.096431	WATER9	0.0000106	WATER9	13.05	EPI	25400	EPI	0.00186	EPI
Methamidophos	10265-92-6	141.13	EPI	3.5487E-08	8.68E-10	EPI	1.31	CRC89	0.059623	WATER9	9.1593E-06	WATER9	5.407	EPI	1000000	EPI	0.0000744	EPI
Methanol	67-56-1	32.04	EPI	0.000186	0.00000455	EPI	0.7914	CRC89	0.158281	WATER9	0.0000165	WATER9	1	EPI	1000000	EPI	0.000319	EPI
Methidathion	950-37-8	302.32	EPI	2.9313E-07	7.17E-09	EPI			0.04218	WATER9	4.9284E-06	WATER9	21.24	EPI	187	EPI	0.000913	EPI
Methomyl	16752-77-5	162.21	EPI	8.054E-10	1.97E-11	EPI	1.2946	CRC89	0.04759	WATER9	8.3658E-06	WATER9	10	EPI	58000	EPI	0.000482	EPI
Methoxy-5-nitroaniline, 2-	99-59-2	168.15	EPI	6.0098E-07	1.47E-08	EPI	1.2068	CRC89	0.043046	WATER9	7.8494E-06	WATER9	71.31	EPI	115	EPI	0.00169	EPI
Methoxychlor	72-43-5	345.66	EPI	8.2993E-06	0.000000203	EPI	1.41	CRC89	0.022085	WATER9	5.5926E-06	WATER9	26890	EPI	0.1	EPI	0.0428	EPI
Methoxyethanol Acetate, 2-	110-49-6	118.13	EPI	0.0000127	0.000000311	EPI	1.0074	CRC89	0.065835	WATER9	8.7052E-06	WATER9	2.492	EPI	1000000	EPI	0.000396	EPI
Methoxyethanol, 2-	109-86-4	76.1	EPI	0.0000135	0.00000033	EPI	0.9647	CRC89	0.095152	WATER9	0.000011	WATER9	1	EPI	1000000	EPI	0.00018	EPI
Methyl Acetate	79-20-9	74.08	EPI	0.0047016	0.000115	EPI	0.9342	CRC89	0.095776	WATER9	0.000011	WATER9	3.064	EPI	243000	EPI	0.000792	EPI
Methyl Acrylate	96-33-3	86.09	EPI	0.0081357	0.000199	EPI	0.9535	CRC89	0.085998	WATER9	0.0000102	WATER9	5.844	EPI	49400	EPI	0.00175	EPI
Methyl Ethyl Ketone (2-Butanone)	78-93-3	72.11	EPI	0.0023262	0.0000569	EPI	0.7999	CRC89	0.091444	WATER9	0.0000102	WATER9	4.51	EPI	223000	EPI	0.000962	EPI
Methyl Hydrazine	60-34-4	46.07	EPI	1.2919E-06	3.16E-08	EPI	0.866	LANGE	0.129093	WATER9	0.000014	WATER9	13.31	EPI	1000000	EPI	0.000173	EPI
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	100.16	EPI	0.0056419	0.000138	EPI	0.7965	CRC89	0.06978	WATER9	8.3477E-06	WATER9	12.6	EPI	19000	EPI	0.00319	EPI
Methyl Isocyanate	624-83-9	57.05	EPI	0.0378577	0.000926	EPI	0.9588	CRC89	0.116552	WATER9	0.0000131	WATER9	39.6	EPI	48330	EPI	0.0025	EPI
Methyl Methacrylate	80-62-6	100.12	EPI	0.0130417	0.000319	EPI	0.9377	CRC89	0.075045	WATER9	9.2087E-06	WATER9	9.14	EPI	15000	EPI	0.00355	EPI
Methyl Parathion	298-00-0	263.21	EPI	4.0883E-06	0.0000001	EPI	1.358	CRC89	0.024985	WATER9	6.4392E-06	WATER9	729.3	EPI	37.7	EPI	0.00416	EPI
Methyl Phosphonic Acid	993-13-5	96.02	EPI	4.988E-10	1.22E-11	EPI			0.090611	WATER9	0.0000106	WATER9	1.407	EPI	20000	EPI	0.0000984	EPI
Methyl Styrene (Mixed Isomers)	25013-15-4	118.18	EPI	0.1230581	0.00301	EPI			0.078897	WATER9	9.2184E-06	WATER9	715.8	EPI	89	EPI	0.066	EPI
Methyl methanesulfonate	66-27-3	110.13	EPI	0.0001648	0.00000403	EPI	1.2943	CRC89	0.078906	WATER9	0.0000106	WATER9	4.332	EPI	200000	LANGE	0.000138	EPI
Methyl tert-Butyl Ether (MTBE)	1634-04-4	88.15	EPI	0.0239984	0.000587	EPI	0.7353	CRC89	0.075268	WATER9	8.5905E-06	WATER9	11.56	EPI	51000	EPI	0.00211	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2	195.09	EPI	2.61E-16	6.38E-18	EPI			0.056485	WATER9	6.5998E-06	WATER9	201.5	EPI	389.71	EPI	0.00000539	EPI
Methyl-5-Nitroaniline, 2-	99-55-8	152.15	EPI	7.9313E-07	1.94E-08	EPI			0.066666	WATER9	7.7894E-06	WATER9	178.6	EPI	613.11	EPI	0.00384	EPI
Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	147.09	EPI	4.988E-11	1.22E-12	EPI			0.068187	WATER9	7.967E-06	WATER9	72.02	EPI	1000000	EPI	0.0000572	EPI
Methylaniline Hydrochloride, 2-	636-21-5	143.62	EPI	0.0000809	0.00000198	EPI			0.06928	WATER9	8.0949E-06	WATER9	115	EPI	16600	EPI	0.00296	EPI
Methylarsonic acid	124-58-3	139.97	EPI						0.07048	WATER9	8.235E-06	WATER9	43.89	EPI	256000	EPI	0.0000419	EPI
Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7																	
Methylbenzene-1,4-diamine sulfate, 2-	615-50-9																	
Methylcholanthrene, 3-	56-49-5	268.36	EPI	0.0002142	0.00000524	EPI	1.28	CRC89	0.024056	WATER9	6.1428E-06	WATER9	961600	EPI	0.0029	EPI	0.903	EPI
Methylene Chloride	75-09-2	84.93	EPI	0.13287	0.00325	EPI	1.3266	CRC89	0.099939	WATER9	0.0000125	WATER9	21.73	EPI	13000	EPI	0.00354	EPI
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	267.16	EPI	4.661E-10	1.14E-11	EPI			0.045804	WATER9	5.3519E-06	WATER9	5698	EPI	13.9	EPI	0.0197	EPI
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	254.38	EPI	4.9469E-06	0.000000121	EPI			0.047326	WATER9	5.5297E-06	WATER9	2667	EPI	5.4926	EPI	0.0843967	RAGSE
Methylenebisbenzenamine, 4,4'-	101-77-9	198.27	EPI	6.46E-10	1.58E-11	EPI			0.055879	WATER9	6.529E-06	WATER9	2126	EPI	1000	EPI	0.00138	EPI
Methylenediphenyl Diisocyanate	101-68-8	250.26	EPI	0.0000366	0.000000895	EPI	1.197	CRC89	0.024174	WATER9	6.1531E-06	WATER9	284900	EPI	1.836	EPI	0.181	EPI
Methylstyrene, Alpha-	98-83-9	118.18	EPI	0.1042518	0.00255	EPI	0.9106	CRC89	0.062902	WATER9	8.1911E-06	WATER9	697.8	EPI	116	EPI	0.0699	EPI
Metolachlor	51218-45-2	283.8	EPI	3.6795E-07	0.000000009	EPI	1.12	CRC89	0.021922	WATER9	5.4827E-06	WATER9	488.5	EPI	530	EPI	0.00339	EPI
Metribuzin	21087-64-9	214.29	EPI	4.7833E-09	1.17E-10	EPI	1.31	CRC89	0.02734	WATER9	7.1291E-06	WATER9	53.13	EPI	1050	EPI	0.00132	EPI
Mineral oils	8012-95-1	170.34	EPI	334.42355	8.18	EPI			0.061831	WATER9	7.2245E-06	WATER9	4818	EPI	0.0037	EPI	1.96	EPI
Mirex	2385-85-5	545.55	EPI	0.0331562	0.000811	EPI			0.028458	WATER9	3.325E-06	WATER9	356600	EPI	0.085	EPI	0.0516	EPI
Molinate	2212-67-1	187.3	EPI	0.0001676	0.0000041	EPI	1.063	CRC89	0.031561	WATER9	6.8182E-06	WATER9	181.9	EPI	970	EPI	0.0189	EPI
Molybdenum	7439-98-7	95.94	EPI				10.2	CRC89									0.001	RAGSE
Monochloramine	10599-90-3	51.48	EPI														0.001	RAGSE
Monomethylaniline	100-61-8	107.16	EPI	0.000363	0.00000888	EPI	0.9891	CRC89	0.0721	WATER9	9.1284E-06	WATER9	82.08	EPI	5620	EPI	0.00498	EPI
N,N'-Diphenyl-1,4-benzenediamine	74-31-7	260.34	EPI	8.381E-09	2.05E-10	EPI			0.046601	WATER9	5.4449E-06	WATER9	51890	EPI	1.5867	EPI	0.0262	EPI
Naled	300-76-5	380.79	EPI	0.0026615	0.0000651	EPI	1.96	CRC89	0.024567	WATER9	0.00000643	WATER9	126.7	EPI	1.5	EPI	0.0000944	EPI
Naphtha, High Flash Aromatic (HFAN)	64724-95-6																	
Naphthylamine, 2-	91-59-8	143.19	EPI	3.3115E-06	0.000000081	EPI	1.6414	CRC89	0.064451	WATER9	0.0000104	WATER9	2478	EPI	189	EPI	0.00807	EPI
Napropamide	15299-99-7	271.36	EPI	3.4383E-08	8.41E-10	EPI			0.04533	WATER9	5.2965E-06	WATER9	3218	EPI	73	EPI	0.00804	EPI
Nickel Carbonyl	13463-39-3	170.73	CRC89				1.31	CRC89							180	PERRY	0.001	RAGSE
Nickel Oxide	1313-99-1	74.69	EPI				6.72	CRC89									0.001	RAGSE
Nickel Refinery Dust	NA																0.0002	RAGSE
Nickel Soluble Salts	7440-02-0	58.69	EPI				8.9	CRC89									0.0002	RAGSE
Nickel Subsulfide	12035-72-2	240.21	CRC89				5.87	CRC89									0.0002	RAGSE
Nitrate	14797-55-8	62	EPI														0.001	RAGSE
Nitrate + Nitrite (as N)	NA																0.001	RAGSE
Nitrite	14797-65-0	47.01	EPI														0.001	RAGSE
Nitroaniline, 2-	88-74-4	138.13	EPI	2.4121E-06	0.000000059	EPI	0.9015	CRC89	0.051919	WATER9	7.4144E-06	WATER9	111.3	EPI	1470	EPI	0.00446	EPI
Nitroaniline, 4-	100-01-6	138.13	EPI	5.1513E-08	1.26E-09	EPI	1.424	CRC89	0.06366	WATER9	9.7545E-06	WATER9	109.1	EPI	728	EPI	0.00221	EPI
Nitrobenzene	98-95-3	123.11	EPI	0.0009812	0.000024	EPI	1.2037	CRC89	0.068054	WATER9	9.4495E-06	WATER9	226.4	EPI	2090	EPI	0.00541	EPI
Nitrocellulose	9004-70-0	387.3	EPI	1.345E-21	3.29E-23	EPI			0.035759	WATER9	4.1782E-06	WATER9	10	EPI	1000000	EPI	9.86E-09	EPI
Nitrofurantoin	67-20-9	238.16	EPI	5.437E-11	1.33E-12	EPI			0.049451	WATER9	5.7779E-06	WATER9	116.8	EPI	79.5	EPI	0.0000352	EPI
Nitrofurazone	59-87-0	198.14	EPI	1.267E-11	3.1E-13	EPI			0.055904	WATER9	6.5319E-06	WATER9	349.7	EPI	210	EPI	0.000172	EPI
Nitroglycerin	55-63-0	227.09	EPI	3.5405E-06	8.66E-08	EPI	1.5931	CRC89	0.029015	WATER9	7.7428E-06	WATER9	115.8	EPI	1380	EPI	0.000994	EPI
Nitroguanidine	556-88-7	104.07	EPI	1.836E-10	4.49E-12	EPI			0.085876	WATER9	0.00001	WATER9	20.65	EPI	4400	EPI	0.000105	EPI
Nitromethane	75-52-5	61.04	EPI	0.0011693	0.0000286	EPI	1.1371	CRC89	0.119285	WATER9	0.0000139	WATER9	10.32	EPI	111000	EPI	0.000417	EPI
Nitropropane, 2-	79-46-9	89.09	EPI	0.0048651	0.000119	EPI	0.9821	CRC89	0.084697	WATER9	0.0000102	WATER9	30.8	EPI	17000	EPI	0.00206	EPI
Nitroso-N-ethylurea, N-	759-73-9	117.11	EPI	5.3966E-09	1.32E-10	EPI			0.079376	WATER9	9.2745E-06	WATER9	20.98	EPI	13000	EPI	0.00049	EPI
Nitroso-N-methylurea, N-	684-93-5	103.08	EPI	4.0515E-09	9.91E-11	EPI			0.086425	WATER9	0.0000101	WATER9	11	EPI	14400	EPI	0.000395	EPI
Nitroso-di-N-butylamine, N-	924-16-3	158.25	EPI	0.0005397	0.0000132	EPI			0.064942	WATER9	7.5879E-06	WATER9	914.6	EPI	1270	EPI	0.0113	EPI
Nitroso-di-N-propylamine, N-	621-64-7	130.19	EPI	0.00022	0.00000538	EPI	0.9163	CRC89	0.05644	WATER9	7.758E-06	WATER9	275.4	EPI	13000	EPI	0.00233	EPI
Nitrosodiethanolamine, N-	1116-54-7	134.14	EPI	9.321E-15	2.28E-16	EPI			0.072507	WATER9	8.4719E-06	WATER9	1	EPI	1000000	EPI	0.0000247	RAGSE
Nitrosodiethylamine, N-	55-18-5	102.14	EPI	0.0001484	0.00000363	EPI	0.9422	CRC89	0.073841	WATER9	9.1252E-06	WATER9	82.92	EPI	106000	EPI	0.000872	EPI
Nitrosodimethylamine, N-	62-75-9	74.08	EPI	0.0000744	0.00000182	EPI	1.0048	CRC89	0.09877	WATER9	0.0000115	WATER9	22.79	EPI	1000000	EPI	0.000251	EPI
Nitrosodiphenylamine, N-	86-30-6	198.23	EPI	0.000205	5.0143E-06	SSL			0.055887	WATER9	6.5299E-06	WATER9	2632	EPI	35	EPI	0.0145	EPI
Nitrosomethylethylamine, N-	10595-95-6	88.11	EPI	0.0000589	0.00000144	EPI			0.095956	WATER9	0.0000112	WATER9	43.47	EPI	300000	EPI	0.000533	EPI
Nitrosomorpholine [N-]	59-89-2	116.12	EPI	1.0016E-06	2.45E-08	EPI			0.079827	WATER9	9.3271E-06	WATER9	22.51	EPI	1000000	EPI	0.000178	EPI
Nitrosopiperidine [N-]	100-75-4	114.15	EPI	0.0000345	0.000000844	EPI	1.0631	CRC89	0.06989	WATER9	9.1776E-06	WATER9	167.5	EPI	76500	EPI	0.000622	EPI
Nitrosopyrrolidine, N-	930-55-2	100.12	EPI	1.9992E-06	4.89E-08	EPI	1.085	CRC89	0.079971	WATER9	0.0000101	WATER9	91.91	EPI	1000000	EPI	0.000321	EPI
Nitrotoluene, m-	99-08-1	137.14	EPI	0.0003802	0.0000093	EPI	1.1581	CRC89	0.058686	WATER9	8.6541E-06	WATER9	363.2	EPI	500	EPI	0.0113	EPI
Nitrotoluene, o-	88-72-2	137.14	EPI	0.000511	0.0000125	EPI	1.1611	CRC89	0.058754	WATER9	8.6675E-06	WATER9	370.6	EPI	650	EPI	0.00899	EPI
Nitrotoluene, p-	99-99-0	137.14	EPI	0.0002302	0.00000563	EPI	1.1038	CRC89	0.057443	WATER9	8.4083E-06	WATER9	363.2	EPI	442	EPI	0.01	EPI
Nonane, n-	111-84-2	128.26	EPI	139.00245	3.4	EPI	0.7192	CRC89	0.051432	WATER9	6.769E-06	WATER9	796	EPI	0.22	EPI	1.7	EPI
Norflurazon	27314-13-2	303.67	EPI	1.4023E-08	3.43E-10	EPI			0.042055	WATER9	4.9138E-06	WATER9	3118	EPI	33.7	EPI	0.00105	EPI
Nustar	85509-19-9	315.4	EPI	0.0000207	0.000000506	EPI			0.041006	WATER9	4.7912E-06	WATER9	81060	EPI	54	EPI	0.00766	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Octabromodiphenyl Ether	32536-52-0	801.38	EPI	0.0000105	0.000000256	EPI			0.022022	WATER9	2.5731E-06	WATER9	98980	EPI	0.0000743	EPI	0.0306	EPI
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0	296.16	EPI	3.5446E-08	8.67E-10	EPI			0.042763	WATER9	4.9965E-06	WATER9	531.6	EPI	5	EPI	0.0000436	EPI
Octamethylpyrophosphoramide	152-16-9	286.25	EPI	2.58E-15	6.31E-17	EPI	1.09	CRC89	0.02154	WATER9	5.3664E-06	WATER9	20.12	EPI	1000000	EPI	0.0000083	EPI
Octyl Phthalate, di-N-	117-84-0	390.57	EPI	0.0001051	0.00000257	EPI			0.035559	WATER9	4.1548E-06	WATER9	140800	EPI	0.022	EPI	2.43	EPI
Oryzalin	19044-88-3	346.36	EPI	7.8087E-08	1.91E-09	EPI			0.038524	WATER9	4.5013E-06	WATER9	825.4	EPI	2.5	EPI	0.00537	EPI
Oxadiazon	19666-30-9	345.23	EPI	2.9722E-06	7.27E-08	EPI			0.038608	WATER9	4.5111E-06	WATER9	4996	EPI	0.7	EPI	0.028	EPI
Oxamyl	23135-22-0	219.26	EPI	9.6893E-09	2.37E-10	EPI	0.97	CRC89	0.02347	WATER9	5.8716E-06	WATER9	10	EPI	280000	EPI	0.0000449	EPI
Paclobutrazol	76738-62-0	293.8	EPI	3.3851E-09	8.28E-11	EPI	1.22	CRC89	0.022428	WATER9	5.6527E-06	WATER9	922.9	EPI	26	EPI	0.00471	EPI
Paraquat Dichloride	1910-42-5	257.16	EPI	1.316E-11	3.22E-13	EPI			0.046984	WATER9	5.4897E-06	WATER9	6780	EPI	700000	EPI	5.77E-08	EPI
Parathion	56-38-2	291.26	EPI	0.0000122	0.000000298	EPI	1.2681	CRC89	0.022949	WATER9	5.8156E-06	WATER9	2422	EPI	11	EPI	0.0128	EPI
Pebulate	1114-71-2	203.35	EPI	0.0096893	0.000237	EPI	0.9458	CRC89	0.024144	WATER9	6.0507E-06	WATER9	299.1	EPI	100	EPI	0.0397	EPI
Pendimethalin	40487-42-1	281.31	EPI	0.000035	0.000000856	EPI	1.19	CRC89	0.022673	WATER9	5.716E-06	WATER9	5615	EPI	0.3	EPI	0.115	EPI
Pentabromodiphenyl Ether	32534-81-9	564.69	EPI	0.0001447	0.00000354	EPI			0.027811	WATER9	3.2495E-06	WATER9	21660	EPI	0.0000009	EPI	0.0373	EPI
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	564.69	EPI	0.0001447	0.00000354	EPI	2.28	IRIS	0.02164	WATER9	5.5584E-06	WATER9	21660	EPI	0.0000009	EPI	0.0373	EPI
Pentachlorobenzene	608-93-5	250.34	EPI	0.0287408	0.000703	EPI	1.8342	CRC89	0.029433	WATER9	7.9473E-06	WATER9	3708	EPI	0.831	EPI	0.168	EPI
Pentachloroethane	76-01-7	202.3	EPI	0.0793132	0.00194	EPI	1.6796	CRC89	0.031517	WATER9	8.5664E-06	WATER9	136.2	EPI	480	EPI	0.0158	EPI
Pentachloronitrobenzene	82-68-8	295.34	EPI	0.001807	0.0000442	EPI	1.718	CRC89	0.026274	WATER9	6.9198E-06	WATER9	5996	EPI	0.44	EPI	0.0418	EPI
Pentachlorophenol	87-86-5	266.34	EPI	1.0016E-06	2.45E-08	EPI	1.978	CRC89	0.02952	WATER9	8.0121E-06	WATER9	4959	EPI	14	EPI	0.127	EPI
Pentaerythritol tetranitrate (PETN)	78-11-5	316.14	EPI	4.906E-10	1.2E-11	EPI	1.773	CRC89	0.025756	WATER9	6.7697E-06	WATER9	647.9	EPI	43	EPI	0.00101	EPI
Pentane, n-	109-66-0	72.15	EPI	51.103843	1.25	EPI	0.6262	CRC89	0.08213	WATER9	8.7975E-06	WATER9	72.17	EPI	38	EPI	0.11	EPI
Perchlorates																		
~Ammonium Perchlorate	7790-98-9	117.49	EPI				1.95	CRC89							200000	EPI	0.001	RAGSE
~Lithium Perchlorate	7791-03-9	106.39	CRC89				2.428	CRC89							587000	CRC89	0.001	RAGSE
~Perchlorate and Perchlorate Salts	14797-73-0	117.49	CRC89												245000	CRC89	0.001	RAGSE
~Potassium Perchlorate	7778-74-7	138.55	EPI				2.52	CRC89							15000	EPI	0.002	RAGSE
~Sodium Perchlorate	7601-89-0	122.44	EPI				2.52	CRC89							2100000	EPI	0.001	RAGSE
Permethrin	52645-53-1	391.3	EPI	0.0000765	0.00000187	EPI	1.23	CRC89	0.019376	WATER9	4.7831E-06	WATER9	118800	EPI	0.006	EPI	0.208	EPI
Phenacetin	62-44-2	179.22	EPI	8.7081E-09	2.13E-10	EPI			0.059772	WATER9	6.9839E-06	WATER9	40.99	EPI	766	EPI	0.00173	EPI
Phenmedipham	13684-63-4	300.32	EPI	3.438E-11	8.41E-13	EPI			0.042367	WATER9	4.9503E-06	WATER9	2594	EPI	4.7	EPI	0.00786	EPI
Phenol	108-95-2	94.11	EPI	0.0000136	0.000000333	EPI	1.0545	CRC89	0.083401	WATER9	0.0000103	WATER9	187.2	EPI	82800	EPI	0.00434	EPI
Phenothiazine	92-84-2	199.27	EPI	0.00000114	2.78E-08	EPI			0.055692	WATER9	6.5072E-06	WATER9	1475	EPI	1.59	EPI	0.0683	EPI
Phenylenediamine, m-	108-45-2	108.14	EPI	5.1104E-08	1.25E-09	EPI	1.0096	CRC89	0.072115	WATER9	9.1911E-06	WATER9	33.83	EPI	238000	EPI	0.000234	EPI
Phenylenediamine, o-	95-54-5	108.14	EPI	2.9436E-07	7.2E-09	EPI			0.083707	WATER9	9.7805E-06	WATER9	34.52	EPI	40400	EPI	0.000487	EPI
Phenylenediamine, p-	106-50-3	108.14	EPI	3.6304E-08	8.88E-10	EPI			0.083707	WATER9	9.7805E-06	WATER9	33.83	EPI	37000	EPI	0.000245	EPI
Phenylphenol, 2-	90-43-7	170.21	EPI	0.0000429	0.00000105	EPI	1.213	CRC89	0.042092	WATER9	7.8162E-06	WATER9	6722	EPI	700	EPI	0.0196	EPI
Phorate	298-02-2	260.37	EPI	0.0001787	0.00000437	EPI	1.16	CRC89	0.023327	WATER9	5.8965E-06	WATER9	459.8	EPI	50	EPI	0.0126	EPI
Phosgene	75-44-5	98.92	EPI	0.6827473	0.0167	EPI	1.3719	CRC89	0.089326	WATER9	0.0000117	WATER9	1	EPI	6825.5	YAWS	0.000147	EPI
Phosmet	732-11-6	317.32	EPI	3.426E-07	8.38E-09	EPI			0.04084	WATER9	4.7719E-06	WATER9	10	EPI	24.4	EPI	0.00183	EPI
Phosphates, Inorganic																		
~Aluminum metaphosphate	13776-88-0	263.9	CRC89				2.779	CRC89									0.001	RAGSE
~Ammonium polyphosphate	68333-79-9																0.001	RAGSE
~Calcium pyrophosphate	7790-76-3	254.1	CRC89				3.09	CRC89									0.001	RAGSE
~Diammonium phosphate	7783-28-0	132.06	EPI														0.001	RAGSE
~Dicalcium phosphate	7757-93-9	136.06	EPI														0.001	RAGSE
~Dimagnesium phosphate	7782-75-4	174.33	CRC89				2.123	CRC89									0.001	RAGSE
~Dipotassium phosphate	7758-11-4	174.18	EPI														0.001	RAGSE
~Disodium phosphate	7558-79-4	141.96	EPI														0.001	RAGSE
~Monoaluminum phosphate	13530-50-2	317.94	CRC89														0.001	RAGSE
~Monoammonium phosphate	7722-76-1	115.03	EPI														0.001	RAGSE
~Monocalcium phosphate	7758-23-8	234.05	EPI														0.001	RAGSE
~Monomagnesium phosphate	7757-86-0	120.28	CRC89														0.001	RAGSE
~Monopotassium phosphate	7778-77-0	136.09	EPI														0.001	RAGSE
~Monosodium phosphate	7558-80-7	119.98	EPI														0.001	RAGSE
~Polyphosphoric acid	8017-16-1	257.96	EPI														0.001	RAGSE
~Potassium tripolyphosphate	13845-36-8																0.001	RAGSE
~Sodium acid pyrophosphate	7758-16-9	221.94	EPI														0.001	RAGSE
~Sodium aluminum phosphate (acidic)	7785-88-8																0.001	RAGSE
~Sodium aluminum phosphate (anhydrous)	10279-59-1																0.001	RAGSE
~Sodium aluminum phosphate (tetrahydrate)	10305-76-7																0.001	RAGSE
~Sodium hexametaphosphate	10124-56-8	611.17	CRC89														0.001	RAGSE
~Sodium polyphosphate	68915-31-1	359.92	EPI														0.001	RAGSE
~Sodium trimetaphosphate	7785-84-4	305.89	EPI														0.001	RAGSE
~Sodium tripolyphosphate	7758-29-4	367.86	EPI														0.001	RAGSE

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
~Tetrapotassium phosphate	7320-34-5	330.34	EPI														0.001	RAGSE
~Tetrasodium pyrophosphate	7722-88-5	265.9	EPI														0.001	RAGSE
~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5																0.001	RAGSE
~Tricalcium phosphate	7758-87-4	310.18	CRC89				3.14	CRC89									0.001	RAGSE
~Trimagnesium phosphate	7757-87-1	262.86	CRC89														0.001	RAGSE
~Tripotassium phosphate	7778-53-2	212.27	EPI														0.001	RAGSE
~Trisodium phosphate	7601-54-9	163.94	EPI														0.001	RAGSE
Phosphine	7803-51-2	34	EPI				1.39	CRC89							3.3	EPI	0.001	RAGSE
Phosphoric Acid	7664-38-2	98	EPI				1.834	PERRY							5480000	CRC89	0.001	RAGSE
Phosphorus, White	7723-14-0	30.974	CRC89				2.69	CRC89							3.3	EPI	0.001	RAGSE
Phthalic Acid, P-	100-21-0	166.13	EPI	1.586E-11	3.88E-13	EPI	1.51	PERRY	0.048723	WATER9	9.0446E-06	WATER9	79.24	EPI	15	EPI	0.00391	EPI
Phthalic Anhydride	85-44-9	148.12	EPI	6.6639E-07	1.63E-08	EPI	1.527	CRC89	0.05948	WATER9	9.7545E-06	WATER9	10	EPI	6200	EPI	0.00267	EPI
Picloram	1918-02-1	241.46	EPI	2.179E-12	5.33E-14	EPI			0.048999	WATER9	5.7252E-06	WATER9	38.77	EPI	430	EPI	0.00127	EPI
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	199.12	EPI	7.604E-13	1.86E-14	EPI			0.05572	WATER9	6.5104E-06	WATER9	226.5	EPI	1400	EPI	0.000496	EPI
Pirimiphos, Methyl	29232-93-7	305.33	EPI	0.0000287	0.000000701	EPI	1.17	CRC89	0.021542	WATER9	5.3867E-06	WATER9	374.7	EPI	8.6	EPI	0.0187	EPI
Polybrominated Biphenyls	59536-65-1																	
Polychlorinated Biphenyls (PCBs)																		
~Aroclor 1016	12674-11-2	257.55	EPI	0.0081766	0.0002	EPI			0.046937	WATER9	5.4842E-06	WATER9	47700	EPI	0.42	EPI	0.305	EPI
~Aroclor 1221	11104-28-2	188.66	EPI	0.0300899	0.000736	EPI			0.057761	WATER9	6.7489E-06	WATER9	8397	EPI	15	EPI	0.168	EPI
~Aroclor 1232	11141-16-5	188.66	EPI	0.0300899	0.000736	EPI			0.057761	WATER9	6.7489E-06	WATER9	8397	EPI	1.45	EPI	0.168	EPI
~Aroclor 1242	53469-21-9	291.99	EPI	0.0077678	0.00019	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.277	EPI	0.545	EPI
~Aroclor 1248	12672-29-6	291.99	EPI	0.0179886	0.00044	EPI			0.043169	WATER9	5.044E-06	WATER9	76530	EPI	0.1	EPI	0.475	EPI
~Aroclor 1254	11097-69-1	326.44	EPI	0.0115699	0.000283	EPI			0.040076	WATER9	4.6826E-06	WATER9	130500	EPI	0.043	EPI	0.751	EPI
~Aroclor 1260	11096-82-5	395.33	EPI	0.0137367	0.000336	EPI			0.035273	WATER9	4.1214E-06	WATER9	349700	EPI	0.0144	EPI	0.986	EPI
~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	395.33	EPI	0.0056419	0.000138	EPI			0.035273	WATER9	4.1214E-06	WATER9	349700	EPI	0.000753	EPI	2.96	EPI
~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	360.88	EPI	0.0066231	0.000162	EPI			0.037484	WATER9	4.3797E-06	WATER9	209300	EPI	0.00223	EPI	1.43	EPI
~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	360.88	EPI	0.0066231	0.000162	EPI			0.037484	WATER9	4.3797E-06	WATER9	213600	EPI	0.0016469	EPI	1.66	EPI
~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	360.88	EPI	0.0058463	0.000143	EPI			0.037484	WATER9	4.3797E-06	WATER9	213600	EPI	0.00533	EPI	1.66	EPI
~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	360.88	EPI	0.0066231	0.000162	EPI			0.037484	WATER9	4.3797E-06	WATER9	209300	EPI	0.00051	EPI	1.24	EPI
~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	326.44	EPI	0.0077678	0.00019	EPI			0.040076	WATER9	4.6826E-06	WATER9	130500	EPI	0.016	EPI	1	EPI
~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	326.44	EPI	0.0117743	0.000288	EPI			0.040076	WATER9	4.6826E-06	WATER9	127900	EPI	0.0134	EPI	1.24	EPI
~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	326.44	EPI	0.0115699	0.000283	EPI			0.040076	WATER9	4.6826E-06	WATER9	130500	EPI	0.0034	EPI	0.751	EPI
~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	326.44	EPI	0.0077678	0.00019	EPI			0.040076	WATER9	4.6826E-06	WATER9	130500	EPI	0.016	EPI	1	EPI
~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	326.44	EPI	0.0077678	0.00019	EPI			0.040076	WATER9	4.6826E-06	WATER9	127900	EPI	0.0073282	EPI	1	EPI
~Polychlorinated Biphenyls (high risk)	1336-36-3	291.99	EPI	0.0077678	0.00019	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.7	SSL	0.545	EPI
~Polychlorinated Biphenyls (low risk)	1336-36-3	291.99	EPI	0.0077678	0.00019	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.7	SSL	0.545	EPI
~Polychlorinated Biphenyls (lowest risk)	1336-36-3	291.99	EPI	0.0077678	0.00019	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.7	SSL	0.545	EPI
~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	291.99	EPI	0.0003843	0.0000094	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.000569	EPI	0.917	EPI
~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	291.99	EPI	0.0091169	0.000223	EPI			0.043169	WATER9	5.044E-06	WATER9	78100	EPI	0.032245	EPI	0.584	EPI
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	512.53	EPI	5.397E-10	1.32E-11	EPI			0.029667	WATER9	3.4664E-06	WATER9	10000000000	EPI	1.763E-06	EPI	18.6	EPI
Polynuclear Aromatic Hydrocarbons (PAHs)																		
~Acenaphthene	83-32-9	154.21	EPI	0.0075225	0.000184	EPI	1.222	CRC89	0.050614	WATER9	0.00000833	WATER9	5027	EPI	3.9	EPI	0.086	EPI
~Anthracene	120-12-7	178.24	EPI	0.0022731	0.0000556	EPI	1.28	CRC89	0.038973	WATER9	7.8523E-06	WATER9	16360	EPI	0.0434	EPI	0.142	EPI
~Benz[a]anthracene	56-55-3	228.3	EPI	0.0004906	0.000012	EPI			0.050865	WATER9	5.9431E-06	WATER9	176900	EPI	0.0094	EPI	0.552	EPI
~Benzo(j)fluoranthene	205-82-3	252.32	EPI	8.2993E-06	0.000000203	EPI			0.047583	WATER9	5.5597E-06	WATER9	599400	EPI	0.0025	EPI	0.69	EPI
~Benzo[a]pyrene	50-32-8	252.32	EPI	0.0000187	0.000000457	EPI			0.047583	WATER9	5.5597E-06	WATER9	587400	EPI	0.00162	EPI	0.713	EPI
~Benzo[b]fluoranthene	205-99-2	252.32	EPI	0.0000269	0.000000657	EPI			0.047583	WATER9	5.5597E-06	WATER9	599400	EPI	0.0015	EPI	0.417	EPI
~Benzo[k]fluoranthene	207-08-9	252.32	EPI	0.0000239	0.000000584	EPI			0.047583	WATER9	5.5597E-06	WATER9	587400	EPI	0.0008	EPI	0.691	EPI
~Chrysene	218-01-9	228.3	EPI	0.0002138	0.00000523	EPI	1.274	CRC89	0.026114	WATER9	6.7495E-06	WATER9	180500	EPI	0.002	EPI	0.596	EPI
~Dibenz[a,h]anthracene	53-70-3	278.36	EPI	5.7645E-06	0.000000141	EPI			0.044567	WATER9	5.2073E-06	WATER9	1912000	EPI	0.00249	EPI	0.953	EPI
~Dibenzo(a,e)pyrene	192-65-4	302.38	EPI	5.7645E-07	1.41E-08	EPI			0.042175	WATER9	4.9278E-06	WATER9	6479000	EPI	0.0000425	EPI	4.19	EPI
~Dimethylbenz(a)anthracene, 7,12-	57-97-6	256.35	EPI	0.0001537	0.00000376	EPI			0.047083	WATER9	5.5013E-06	WATER9	493600	EPI	0.061	EPI	0.408	EPI
~Fluoranthene	206-44-0	202.26	EPI	0.0003622	0.00000886	EPI	1.252	CRC89	0.027596	WATER9	7.1827E-06	WATER9	55450	EPI	0.26	EPI	0.308	EPI
~Fluorene	86-73-7	166.22	EPI	0.003933	0.0000962	EPI	1.203	CRC89	0.043974	WATER9	7.889E-06	WATER9	9160	EPI	1.69	EPI	0.11	EPI
~Indeno[1,2,3-cd]pyrene	193-39-5	276.34	EPI	0.0000656	1.6046E-06	SSL			0.044784	WATER9	5.2327E-06	WATER9	3470000	SSL	0.000022	SSL	1.0408205	RAGSE
~Methylnaphthalene, 1-	90-12-0	142.2	EPI	0.0210139	0.000514	EPI	1.0202	CRC89	0.052771	WATER9	7.8477E-06	WATER9	2528	EPI	25.8	EPI	0.0931	EPI
~Methylnaphthalene, 2-	91-57-6	142.2	EPI	0.0211774	0.000518	EPI	1.0058	CRC89	0.052432	WATER9	7.7811E-06	WATER9	2478	EPI	24.6	EPI	0.0917	EPI
~Naphthalene	91-20-3	128.18	EPI	0.0179886	0.00044	EPI	1.0253	CRC89	0.060499	WATER9	8.377E-06	WATER9	1544	EPI	31	EPI	0.0466	EPI
~Nitropyrene, 4-	57835-92-4	247.26	EPI	1.0016E-06	2.45E-08	EPI			0.04823	WATER9	5.6353E-06	WATER9	86110	EPI	0.044505	EPI	0.0922	EPI
~Pyrene	129-00-0	202.26	EPI	0.0004865	0.0000119	EPI	1.271	CRC89	0.027787	WATER9	7.2479E-06	WATER9	54340	EPI	0.135	EPI	0.201	EPI
Prochloraz	67747-09-5	376.67	EPI	6.7048E-07	1.64E-08	EPI			0.036429	WATER9	4.2564E-06	WATER9	2425	EPI	34	EPI	0.0064	EPI
Profluralin	26399-36-0	347.3	EPI	0.0118561	0.00029	EPI			0.038455	WATER9	4.4931E-06	WATER9	30520	EPI	0.1	EPI	0.09	EPI
Prometon	1610-18-0	225.3	EPI	3.7163E-08	9.09E-10	EPI			0.051315	WATER9	5.9958E-06	WATER9	137.4	EPI	750	EPI	0.00827	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Prometryn	7287-19-6	241.36	EPI	4.8651E-07	1.19E-08	EPI	1.157	CRC89	0.024246	WATER9	6.1613E-06	WATER9	656.4	EPI	33	EPI	0.0149	EPI
Propachlor	1918-16-7	211.69	EPI	0.0000147	0.00000036	EPI	1.242	CRC89	0.026846	WATER9	6.9554E-06	WATER9	204.5	EPI	580	EPI	0.00286	EPI
Propanil	709-98-8	218.08	EPI	6.991E-08	1.71E-09	EPI	1.25	CRC89	0.026511	WATER9	6.8588E-06	WATER9	175.9	EPI	152	EPI	0.0103	EPI
Propargite	2312-35-8	350.48	EPI	0.0000262	0.00000064	EPI	1.1	CRC89	0.01944	WATER9	4.7787E-06	WATER9	36650	EPI	0.215	EPI	0.0356	EPI
Propargyl Alcohol	107-19-7	56.06	EPI	0.000047	0.00000115	EPI	0.9478	CRC89	0.117395	WATER9	0.0000131	WATER9	1.904	EPI	1000000	EPI	0.000424	EPI
Propazine	139-40-2	229.71	EPI	1.8806E-07	4.6E-09	EPI	1.162	CRC89	0.024935	WATER9	6.3634E-06	WATER9	344.1	EPI	8.6	EPI	0.00713	EPI
Propham	122-42-9	179.22	EPI	7.5225E-06	0.000000184	EPI	1.09	CRC89	0.03575	WATER9	7.1072E-06	WATER9	218.6	EPI	179	EPI	0.00826	EPI
Propiconazole	60207-90-1	342.23	EPI	7.0319E-08	1.72E-09	EPI	1.27	CRC89	0.021111	WATER9	5.284E-06	WATER9	1556	EPI	110	EPI	0.00558	EPI
Propionaldehyde	123-38-6	58.08	EPI	0.0030008	0.0000734	EPI	0.8657	CRC89	0.110378	WATER9	0.0000122	WATER9	1	EPI	306000	EPI	0.00182	EPI
Propyl benzene	103-65-1	120.2	EPI	0.4292723	0.0105	EPI	0.8593	CRC89	0.060156	WATER9	7.831E-06	WATER9	813.1	EPI	52.2	EPI	0.0939	EPI
Propylene	115-07-1	42.08	EPI	8.0130826	0.196	EPI	0.505	CRC89	0.109699	WATER9	0.0000107	WATER9	21.73	EPI	200	EPI	0.0136	EPI
Propylene Glycol	57-55-6	76.1	EPI	5.2739E-07	1.29E-08	EPI	1.0361	CRC89	0.098065	WATER9	0.0000115	WATER9	1	EPI	1000000	EPI	0.000143	EPI
Propylene Glycol Dinitrate	6423-43-4	166.09	EPI	0.0000385	0.000000942	EPI			0.062882	WATER9	7.3472E-06	WATER9	60.7	EPI	3261.9	EPI	0.00208	EPI
Propylene Glycol Monoethyl Ether	1569-02-4	104.15	EPI	1.0016E-06	2.45E-08	EPI			0.085832	WATER9	0.00001	WATER9	1.303	EPI	789970	EPI	0.000409	EPI
Propylene Glycol Monomethyl Ether	107-98-2	90.12	EPI	0.0000376	0.00000092	EPI	0.962	CRC89	0.083147	WATER9	9.9606E-06	WATER9	1	EPI	1000000	EPI	0.0003717	RAGSE
Propylene Oxide	75-56-9	58.08	EPI	0.0028455	0.0000696	EPI	0.831	PERRY	0.108512	WATER9	0.0000119	WATER9	5.194	EPI	590000	EPI	0.000774	EPI
Pursuit	81335-77-5	289.34	EPI	4.252E-15	1.04E-16	EPI			0.043433	WATER9	5.0747E-06	WATER9	339.1	EPI	1400	EPI	0.002	EPI
Pydrin	51630-58-1	419.91	EPI	1.4105E-06	3.45E-08	EPI	1.15	CRC89	0.018059	WATER9	4.4035E-06	WATER9	317000	EPI	0.024	EPI	0.0938	EPI
Pyridine	110-86-1	79.1	EPI	0.0004497	0.000011	EPI	0.9819	CRC89	0.09309	WATER9	0.0000109	WATER9	71.72	EPI	1000000	EPI	0.00152	EPI
Quinalphos	13593-03-8	298.3	EPI	1.897E-06	4.64E-08	EPI			0.042558	WATER9	4.9726E-06	WATER9	4185	EPI	22	EPI	0.0296	EPI
Quinoline	91-22-5	129.16	EPI	0.0000683	0.00000167	EPI	1.0977	CRC89	0.0618	WATER9	8.6873E-06	WATER9	1544	EPI	6110	EPI	0.00659	EPI
Refractory Ceramic Fibers	NA																0.001	RAGSE
Resmethrin	10453-86-8	338.45	EPI	5.4374E-06	0.000000133	EPI			0.039122	WATER9	4.5711E-06	WATER9	311400	EPI	0.0379	EPI	0.238	EPI
Ronnel	299-84-3	321.54	EPI	0.0013083	0.000032	EPI	1.44	CRC89	0.023158	WATER9	5.9149E-06	WATER9	4457	EPI	1	EPI	0.043	EPI
Rotenone	83-79-4	394.43	EPI	4.579E-12	1.12E-13	EPI			0.035327	WATER9	4.1277E-06	WATER9	261100	EPI	0.2	EPI	0.00509	EPI
Safrole	94-59-7	162.19	EPI	0.0003708	0.00000907	EPI	1.1	CRC89	0.044227	WATER9	7.5874E-06	WATER9	207.2	EPI	5.8996	EPI	0.011285	RAGSE
Savey	78587-05-0	352.88	EPI	9.6893E-07	2.37E-08	EPI			0.038048	WATER9	4.4456E-06	WATER9	2120	EPI	0.5	EPI	0.0828	EPI
Selenious Acid	7783-00-8	128.97	EPI				3	CRC89							900000	PERRY	0.001	RAGSE
Selenium	7782-49-2	78.96	CRC89				4.809	CRC89									0.001	RAGSE
Selenium Sulfide	7446-34-6	111.02	EPI														0.001	RAGSE
Sethoxydim	74051-80-2	327.49	EPI	8.831E-10	2.16E-11	EPI	1.043	CRC89	0.019633	WATER9	4.8208E-06	WATER9	4374	EPI	25	EPI	0.0185	EPI
Silica (crystalline, respirable)	7631-86-9	60.08	EPI				2.32	PERRY									0.001	RAGSE
Silver	7440-22-4	107.87	EPI				10.5	CRC89									0.0006	RAGSE
Simazine	122-34-9	201.66	EPI	3.8512E-08	9.42E-10	EPI	1.302	CRC89	0.028139	WATER9	7.3666E-06	WATER9	146.5	EPI	6.2	EPI	0.00325	EPI
Sodium Acifluorfen	62476-59-9	383.65	EPI	2.4734E-09	6.05E-11	EPI			0.035986	WATER9	4.2046E-06	WATER9	3880	EPI	250000	EPI	0.0000195	EPI
Sodium Azide	26628-22-8	65.01	EPI				1.846	CRC89							408000	CRC89	0.001	RAGSE
Sodium Diethyldithiocarbamate	148-18-5	171.25	EPI						0.061612	WATER9	7.1989E-06	WATER9	204.5	EPI	427890	EPI	0.0000192	EPI
Sodium Fluoride	7681-49-4	41.99	EPI				2.78	CRC89							42200	EPI	0.001	RAGSE
Sodium Fluoroacetate	62-74-8	100.03	EPI	0.0000446	0.00000109	EPI			0.088173	WATER9	0.0000103	WATER9	1.44	EPI	1110000	EPI	0.00000132	EPI
Sodium Metavanadate	13718-26-8	121.93	CRC89												210000	CRC89	0.001	RAGSE
Stirofos (Tetrachlorovinphos)	961-11-5	365.97	EPI	7.5225E-08	1.84E-09	EPI			0.037136	WATER9	4.339E-06	WATER9	1375	EPI	11	EPI	0.00307	EPI
Strontium, Stable	7440-24-6	87.62	EPI				2.64	CRC89									0.001	RAGSE
Strychnine	57-24-9	334.42	EPI	2.437E-12	5.96E-14	EPI	1.36	CRC89	0.022082	WATER9	5.5824E-06	WATER9	5403	EPI	160	EPI	0.000399	EPI
Styrene	100-42-5	104.15	EPI	0.1124285	0.00275	EPI	0.9016	CRC89	0.071114	WATER9	8.7838E-06	WATER9	446.1	EPI	310	EPI	0.0372	EPI
Sulfolane	126-33-0	120.17	EPI	0.000198	0.00000485	EPI	1.2723	CRC89	0.0716	WATER9	9.9117E-06	WATER9	9.079	EPI	292860	EPI	0.000102	EPI
Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	287.16	EPI	5.601E-06	0.000000137	EPI			0.043652	WATER9	5.1004E-06	WATER9	2855	EPI	0.51209	EPI	0.0149	EPI
Sulfuric Acid	7664-93-9	98.07	EPI				1.8302	CRC89							1000000	EPI	0.001	RAGSE
Systhane	88671-89-0	288.78	EPI	1.7498E-07	4.28E-09	EPI			0.043489	WATER9	5.0813E-06	WATER9	6075	EPI	142	EPI	0.00337	EPI
TCMTB	21564-17-0	238.34	EPI	2.653E-10	6.49E-12	EPI			0.049426	WATER9	5.775E-06	WATER9	3374	EPI	125	EPI	0.0112	EPI
Tebuthiuron	34014-18-1	228.31	EPI	4.906E-09	1.2E-10	EPI			0.050863	WATER9	5.943E-06	WATER9	42.35	EPI	2500	EPI	0.00127	EPI
Temephos	3383-96-8	466.46	EPI	8.0131E-08	1.96E-09	EPI	1.32	CRC89	0.018295	WATER9	4.4908E-06	WATER9	95060	EPI	0.27	EPI	0.0345	EPI
Terbacil	5902-51-2	216.67	EPI	4.906E-09	1.2E-10	EPI	1.34	CRC89	0.027468	WATER9	7.1789E-06	WATER9	50.1	EPI	710	EPI	0.00172	EPI
Terbufos	13071-79-9	288.42	EPI	0.0009812	0.000024	EPI	1.105	CRC89	0.021596	WATER9	5.3861E-06	WATER9	998.9	EPI	5.07	EPI	0.0358	EPI
Terbutryn	886-50-0	241.36	EPI	8.7899E-07	2.15E-08	EPI	1.115	CRC89	0.023826	WATER9	6.0261E-06	WATER9	607	EPI	25	EPI	0.0212	EPI
Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	485.8	EPI	0.0003467	0.00000848	EPI			0.030746	WATER9	3.5924E-06	WATER9	13230	EPI	0.054234	EPI	0.0929	EPI
Tetrachlorobenzene, 1,2,4,5-	95-94-3	215.89	EPI	0.0408831	0.001	EPI	1.858	CRC89	0.031896	WATER9	8.7531E-06	WATER9	2220	EPI	0.595	EPI	0.117	EPI
Tetrachloroethane, 1,1,1,2-	630-20-6	167.85	EPI	0.1022077	0.0025	EPI	1.5406	CRC89	0.048176	WATER9	9.0977E-06	WATER9	86.03	EPI	1070	EPI	0.0159	EPI
Tetrachloroethane, 1,1,2,2-	79-34-5	167.85	EPI	0.0150041	0.000367	EPI	1.5953	CRC89	0.048921	WATER9	9.2902E-06	WATER9	94.94	EPI	2830	EPI	0.00694	EPI
Tetrachloroethylene	127-18-4	165.83	EPI	0.7236304	0.0177	EPI	1.623	CRC89	0.050466	WATER9	9.4551E-06	WATER9	94.94	EPI	206	EPI	0.0334	EPI
Tetrachlorophenol, 2,3,4,6-	58-90-2	231.89	EPI	0.0003614	0.00000884	EPI			0.050338	WATER9	5.8816E-06	WATER9	2969	EPI	23	EPI	0.071	EPI
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	229.92	EPI	0.0078904	0.000193	EPI	1.4463	CRC89	0.027587	WATER9	7.2524E-06	WATER9	1606	EPI	6.1149	EPI	0.0836	EPI
Tetraethyl Dithiopyrophosphate	3689-24-5	322.31	EPI	0.0001819	0.00000445	EPI	1.196	CRC89	0.021162	WATER9	5.2838E-06	WATER9	265.6	EPI	30	EPI	0.0109	EPI
Tetrafluoroethane, 1,1,1,2-	811-97-2	102.03	EPI	2.0441537	0.05	EPI	1.2072	CRC89	0.082307	WATER9	0.0000106	WATER9	86.03	EPI	1089.7	EPI	0.00548	EPI

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	287.15	EPI	1.1079E-07	2.71E-09	EPI	1.57	CRC89	0.025563	WATER9	6.6672E-06	WATER9	4605	EPI	74	EPI	0.000474	EPI
Thallium (I) Nitrate	10102-45-1	266.39	EPI				5.55	CRC89							95500	EPI	0.001	RAGSE
Thallium (Soluble Salts)	7440-28-0	204.38	EPI				11.8	CRC89									0.001	RAGSE
Thallium Acetate	563-68-8	263.43	EPI				3.68	CRC89							10000	EPI	0.001	RAGSE
Thallium Carbonate	6533-73-9	468.78	EPI				7.11	CRC89							52000	EPI	0.001	RAGSE
Thallium Chloride	7791-12-0	239.84	EPI				7	CRC89							2900	EPI	0.001	RAGSE
Thallium Sulfate	7446-18-6	504.82	EPI				6.77	CRC89							54700	CRC89	0.001	RAGSE
Thiobencarb	28249-77-6	257.78	EPI	0.0000109	0.000000267	EPI	1.16	CRC89	0.02345	WATER9	5.9319E-06	WATER9	1628	EPI	28	EPI	0.0102	EPI
Thiodiglycol	111-48-8	122.18	EPI	1.12E-11	2.74E-13	EPI	1.1793	CRC89	0.068021	WATER9	9.3766E-06	WATER9	1	EPI	1000000	EPI	0.000123	EPI
Thiofanox	39196-18-4	218.32	EPI	3.8389E-07	9.39E-09	EPI			0.052403	WATER9	6.1229E-06	WATER9	72.4	EPI	5200	EPI	0.00627	EPI
Thiophanate, Methyl	23564-05-8	342.39	EPI	4.9469E-08	1.21E-09	EPI			0.038822	WATER9	4.536E-06	WATER9	327.4	EPI	26.6	EPI	0.00016	EPI
Thiram	137-26-8	240.42	EPI	7.4407E-06	0.000000182	EPI	1.29	PERRY	0.025567	WATER9	6.5924E-06	WATER9	611.4	EPI	30	EPI	0.00099	EPI
Tin	7440-31-5	118.71	CRC89				7.287	CRC89									0.001	RAGSE
Titanium Tetrachloride	7550-45-0	189.68	EPI				1.73	CRC89									0.001	RAGSE
Toluene	108-88-3	92.14	EPI	0.2714636	0.00664	EPI	0.8623	CRC89	0.077805	WATER9	9.2045E-06	WATER9	233.9	EPI	526	EPI	0.0311	EPI
Toluene-2,5-diamine	95-70-5	122.17	EPI	3.8921E-08	9.52E-10	EPI			0.077169	WATER9	9.0166E-06	WATER9	55.39	EPI	13847	EPI	0.00041	EPI
Toluidine, p-	106-49-0	107.16	EPI	0.0000826	0.00000202	EPI	0.9619	CRC89	0.071219	WATER9	8.977E-06	WATER9	112.7	EPI	6500	EPI	0.00329	EPI
Toxaphene	8001-35-2	413.82	EPI	0.0002453	0.000006	EPI			0.034215	WATER9	3.9977E-06	WATER9	77200	EPI	0.74	SSL	0.0518	EPI
Tralomethrin	66841-25-6	665.02	EPI	1.6108E-08	3.94E-10	EPI			0.024938	WATER9	2.9138E-06	WATER9	191100	EPI	0.08	EPI	0.0305	EPI
Tri-n-butyltin	688-73-3	291.07	EPI	62.142273	1.52	EPI	1.103	CRC89	0.021473	WATER9	5.3508E-06	WATER9	8091	EPI	0.82457	EPI	0.0193	EPI
Triacetin	102-76-1	218.21	EPI	5.03E-07	1.23E-08	EPI	1.1583	CRC89	0.02558	WATER9	0.00000655	WATER9	40.73	EPI	58000	EPI	0.000137	EPI
Triallate	2303-17-5	304.66	EPI	0.0004906	0.000012	EPI	1.273	CRC89	0.022458	WATER9	5.6739E-06	WATER9	1008	EPI	4	EPI	0.0349	EPI
Triasulfuron	82097-50-5	401.83	EPI	1.321E-11	3.23E-13	EPI			0.034892	WATER9	4.0769E-06	WATER9	427.2	EPI	32	EPI	0.0000469	EPI
Tribromobenzene, 1,2,4-	615-54-3	314.8	EPI	0.0158626	0.000388	EPI			0.041058	WATER9	4.7973E-06	WATER9	614.3	EPI	4.9	EPI	0.0337	EPI
Tributyl Phosphate	126-73-8	266.32	EPI	0.0000576	0.00000141	EPI	0.9727	CRC89	0.021184	WATER9	5.2338E-06	WATER9	2350	EPI	280	EPI	0.0228	EPI
Tributyltin Compounds	NA																	
Tributyltin Oxide	56-35-9	596.12	EPI	0.0000123	0.000000302	EPI	1.17	CRC89	0.015124	WATER9	3.6056E-06	WATER9	25930000	EPI	19.5	EPI	0.000252	EPI
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	187.38	EPI	21.504497	0.526	EPI	1.5635	CRC89	0.037566	WATER9	8.592E-06	WATER9	196.8	EPI	170	EPI	0.0175	EPI
Trichloroacetic Acid	76-03-9	163.39	EPI	5.5192E-07	1.35E-08	EPI	1.6126	CRC89	0.051749	WATER9	9.5028E-06	WATER9	3.231	EPI	54600	EPI	0.00145	EPI
Trichloroaniline HCl, 2,4,6-	33663-50-2	232.93	EPI	2.935E-12	7.18E-14	EPI			0.050188	WATER9	5.8641E-06	WATER9	1271	EPI	20.964	EPI	0.0000276	EPI
Trichloroaniline, 2,4,6-	634-93-5	196.46	EPI	0.0000548	0.00000134	EPI			0.056222	WATER9	6.5691E-06	WATER9	4440	EPI	40	EPI	0.027	EPI
Trichlorobenzene, 1,2,3-	87-61-6	181.45	EPI	0.0511038	0.00125	EPI	1.4533	CRC89	0.03953	WATER9	8.3836E-06	WATER9	1383	EPI	18	EPI	0.0738	EPI
Trichlorobenzene, 1,2,4-	120-82-1	181.45	EPI	0.058054	0.00142	EPI	1.459	CRC89	0.039599	WATER9	8.4033E-06	WATER9	1356	EPI	49	EPI	0.0705	EPI
Trichloroethane, 1,1,1-	71-55-6	133.41	EPI	0.7031889	0.0172	EPI	1.339	CRC89	0.064817	WATER9	9.599E-06	WATER9	43.89	EPI	1290	EPI	0.0126	EPI
Trichloroethane, 1,1,2-	79-00-5	133.41	EPI	0.0336877	0.000824	EPI	1.4397	CRC89	0.06689	WATER9	0.00001	WATER9	60.7	EPI	4590	EPI	0.00504	EPI
Trichloroethylene	79-01-6	131.39	EPI	0.4026983	0.00985	EPI	1.4642	CRC89	0.068662	WATER9	0.0000102	WATER9	60.7	EPI	1280	EPI	0.0116	EPI
Trichlorofluoromethane	75-69-4	137.37	EPI	3.9656582	0.097	EPI	1.4879	CRC89	0.065356	WATER9	0.00001	WATER9	43.89	EPI	1100	EPI	0.0127	EPI
Trichlorophenol, 2,4,5-	95-95-4	197.45	EPI	0.0000662	0.00000162	EPI	1.49	PERRY	0.031394	WATER9	8.0893E-06	WATER9	1777	EPI	1200	EPI	0.0362	EPI
Trichlorophenol, 2,4,6-	88-06-2	197.45	EPI	0.0001063	0.0000026	EPI	1.4901	CRC89	0.031395	WATER9	8.0896E-06	WATER9	1777	EPI	800	EPI	0.0346	EPI
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	255.49	EPI	1.9052E-06	4.66E-08	EPI			0.047189	WATER9	5.5136E-06	WATER9	107	EPI	278	EPI	0.00914	EPI
Trichlorophenoxypropionic acid, -2,4,5	93-72-1	269.51	EPI	3.704E-07	9.06E-09	EPI			0.045538	WATER9	5.3207E-06	WATER9	175.3	EPI	71	EPI	0.0161	EPI
Trichloropropane, 1,1,2-	598-77-6	147.43	EPI	0.0129599	0.000317	EPI	1.372	CRC89	0.057158	WATER9	9.1735E-06	WATER9	94.94	EPI	1900	EPI	0.0096	EPI
Trichloropropane, 1,2,3-	96-18-4	147.43	EPI	0.0140229	0.000343	EPI	1.3889	CRC89	0.057466	WATER9	9.2411E-06	WATER9	115.8	EPI	1750	EPI	0.00752	EPI
Trichloropropene, 1,2,3-	96-19-5	145.42	EPI	0.7195421	0.0176	EPI	1.412	CRC89	0.059063	WATER9	9.4102E-06	WATER9	115.8	EPI	484.19	EPI	0.0169	EPI
Tricresyl Phosphate (TCP)	1330-78-5	368.37	EPI	0.000033	0.000000808	EPI	1.152	Yaws	0.019369	WATER9	4.7684E-06	WATER9	47110	EPI	0.36	EPI	0.0334	EPI
Tridiphane	58138-08-2	320.43	EPI	0.0000168	0.00000041	EPI			0.040576	WATER9	4.7409E-06	WATER9	3447	EPI	1.1696	EPI	0.0689	EPI
Triethylamine	121-44-8	101.19	EPI	0.0060916	0.000149	EPI	0.7275	CRC89	0.066363	WATER9	7.8576E-06	WATER9	50.81	EPI	68600	EPI	0.0039	EPI
Trifluralin	1582-09-8	335.29	EPI	0.004211	0.000103	EPI			0.039368	WATER9	4.5998E-06	WATER9	16390	EPI	0.184	EPI	0.0728	EPI
Trimethyl Phosphate	512-56-1	140.08	EPI	2.9436E-07	7.2E-09	EPI	1.2144	CRC89	0.058255	WATER9	8.7915E-06	WATER9	10.6	EPI	500000	EPI	0.0000948	EPI
Trimethylbenzene, 1,2,3-	526-73-8	120.2	EPI	0.178	0.00436	EPI	0.8944	CRC89	0.061254	WATER9	8.0214E-06	WATER9	626.9	EPI	75.2	EPI	0.0897	EPI
Trimethylbenzene, 1,2,4-	95-63-6	120.2	EPI	0.2518397	0.00616	EPI	0.8758	CRC89	0.060675	WATER9	7.9209E-06	WATER9	614.3	EPI	57	EPI	0.0857	EPI
Trimethylbenzene, 1,3,5-	108-67-8	120.2	EPI	0.3585446	0.00877	EPI	0.8615	CRC89	0.060225	WATER9	7.843E-06	WATER9	602.1	EPI	48.2	EPI	0.0621	EPI
Trinitrobenzene, 1,3,5-	99-35-4	213.11	EPI	2.6574E-07	6.5E-09	EPI	1.4775	CRC89	0.028969	WATER9	7.6882E-06	WATER9	1683	EPI	278	EPI	0.000607	EPI
Trinitrotoluene, 2,4,6-	118-96-7	227.13	EPI	8.5037E-07	2.08E-08	EPI	1.654	CRC89	0.029509	WATER9	7.9182E-06	WATER9	2812	EPI	115	EPI	0.000963	EPI
Triphenylphosphine Oxide	791-28-6	278.29	EPI	2.1504E-08	5.26E-10	EPI	1.2124	CRC89	0.023005	WATER9	5.8178E-06	WATER9	1954	EPI	204.51	EPI	0.00327	EPI
Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8	430.91	EPI	1.067E-07	2.61E-09	EPI			0.033304	WATER9	3.8913E-06	WATER9	11130	EPI	7	EPI	0.00159	EPI
Tris(1-chloro-2-propyl)phosphate	13674-84-5	327.57	EPI	0.00000244	5.96E-08	EPI			0.039984	WATER9	4.6718E-06	WATER9	1604	EPI	1200	EPI	0.0012	EPI
Tris(2-chloroethyl)phosphate	115-96-8	285.49	EPI	0.0001345	0.00000329	EPI	1.39	CRC89	0.024218	WATER9	6.2191E-06	WATER9	388.3	EPI	7000	EPI	0.000355	EPI
Tris(2-ethylhexyl)phosphate	78-42-2	434.65	EPI	3.2134E-06	7.86E-08	EPI	0.99	CRC89	0.016451	WATER9	3.9425E-06	WATER9	2468000	EPI	0.6	EPI	11.6	EPI
Uranium (Soluble Salts)	NA	238.03	CRC89				19.1	CRC89									0.001	RAGSE
Urethane	51-79-6	89.09	EPI	2.6288E-06	6.43E-08	EPI	0.9862	CRC89	0.08485	WATER9	0.0000102	WATER9	12.13	EPI	480000	EPI	0.000394	EPI
Vanadium Pentoxide	1314-62-1	181.88	EPI				3.35	CRC89							700	CRC89	0.001	RAGSE
Vanadium and Compounds	7440-62-2	50.94	EPI				6	CRC89									0.001	RAGSE

Contaminant		Molecular Weight		Henry's Law Constants			Density		Diffusivity in Air		Diffusivity in Water		Organic Carbon		Water Solubility		Permeability	
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^3/mole)	H` and HLC Ref	Density (g/cm^3)	Density Ref	Dia (cm^2/s)	Dia Ref	Diw (cm^2/s)	Diw Ref	Koc (L/kg)	Koc Ref	S (mg/L)	S Ref	K_p (cm/hr)	KPREF
Vernolate	1929-77-7	203.35	EPI	0.0012633	0.0000309	EPI	0.952	CRC89	0.024219	WATER9	6.0745E-06	WATER9	299.1	EPI	90	EPI	0.0403	EPI
Vinclozolin	50471-44-8	286.12	EPI	7.1137E-07	1.74E-08	EPI	1.51	CRC89	0.025149	WATER9	6.5272E-06	WATER9	283.6	EPI	2.6	EPI	0.00446	EPI
Vinyl Acetate	108-05-4	86.09	EPI	0.0208913	0.000511	EPI	0.9256	CRC89	0.084902	WATER9	0.00001	WATER9	5.583	EPI	20000	EPI	0.00157	EPI
Vinyl Bromide	593-60-2	106.95	EPI	0.5028618	0.0123	EPI	1.4933	CRC89	0.086224	WATER9	0.0000117	WATER9	21.73	EPI	10358	EPI	0.00435	EPI
Vinyl Chloride	75-01-4	62.5	EPI	1.1365495	0.0278	EPI	0.9106	CRC89	0.107119	WATER9	0.000012	WATER9	21.73	EPI	8800	EPI	0.00838	EPI
Warfarin	81-81-2	308.34	EPI	1.1325E-07	2.77E-09	EPI			0.041629	WATER9	4.8641E-06	WATER9	426.1	EPI	17	EPI	0.00182	EPI
Xylene, P-	106-42-3	106.17	EPI	0.2820932	0.0069	EPI	0.8565	CRC89	0.068249	WATER9	8.4199E-06	WATER9	375.3	EPI	162	EPI	0.0493	EPI
Xylene, m-	108-38-3	106.17	EPI	0.2935405	0.00718	EPI	0.8598	CRC89	0.068366	WATER9	8.4394E-06	WATER9	375.3	EPI	161	EPI	0.0532	EPI
Xylene, o-	95-47-6	106.17	EPI	0.2117743	0.00518	EPI	0.8755	CRC89	0.06892	WATER9	8.5315E-06	WATER9	382.9	EPI	178	EPI	0.0471	EPI
Xylenes	1330-20-7	106.17	EPI	0.2117743	0.00518	EPI			0.08474	WATER9	9.9011E-06	WATER9	382.9	EPI	106	EPI	0.05	EPI
Zinc Phosphide	1314-84-7	258.18	CRC89				4.55	CRC89									0.0006	RAGSE
Zinc and Compounds	7440-66-6	65.38	PERRY				7.134	CRC89									0.0006	RAGSE
Zineb	12122-67-7	275.74	EPI	6.5004E-09	1.59E-10	EPI			0.044849	WATER9	5.2403E-06	WATER9	1345	EPI	10	EPI	0.000325	EPI
Zirconium	7440-67-7	91.22	EPI				6.52	CRC89									0.001	RAGSE

APPENDIX D

Site-Specific Sampling and Analysis Plan

APPENDIX D

FINAL

SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN (INCLUDING SITE-SPECIFIC UFP- QUALITY ASSURANCE PROJECT PLAN) FOR RI/FS ENVIRONMENTAL INVESTIGATIONS FOR THE WWI INCINERATOR, NW CAMP FUNSTON (CFI) – OPERABLE UNIT 007 AT FORT RILEY, KANSAS

November 15, 2013

Prepared for

U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Prepared by

Burns & McDonnell
SINCE 1898

Contract Number: W912DQ-08-D-0017
Project Number: 63525

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APPENDICES

Appendix A Laboratory Documentation

- TestAmerica West Sacramento (TestAmerica)
  - *Quality Assurance Manual (QAM)*
  - Standard Operating Procedures
  - Certificate of Accreditation DoD ELAP Laboratory
  - State of Kansas Certification

- Brooks Rand Labs, LLC. (BRL)
  - *Quality Assurance Manual (QAM)*
  - Standard Operating Procedures
  - Certificate of Accreditation DoD ELAP Laboratory

LIST OF TABLES

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12-1	QC Sample Acceptance Limits – Methyl Mercury by EPA Method 1630

LIST OF ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
bgs	below ground surface
BLRA	Baseline Risk Assessment
BMcD	Burns & McDonnell Engineering Company, Inc.
BRL	Brooks Rand Labs, LLC of Seattle, Washington
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CA	Corrective Action
CENWK	Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFI	WWI Incinerator, NW Camp Funston
COC	Chain-of-Custody
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CVAA	Cold Vapor Atomic Absorption
CVAFS	Cold Vapor Atomic Fluorescence Spectrophotometer
DA	United States Department of the Army
DO	Dissolved Oxygen
DoD	Department of Defense
DQI	Data Quality Indicator
DQO	Data Quality Objective
DQCR	Daily Quality Control Report
DRO	Diesel Range Organics
ELAP	Environmental Laboratory Accreditation Program
Fort Riley	Fort Riley Military Reservation
ft	feet
FSM	Field Site Manager
FS	Feasibility Study
FSP	Field Sampling Plan
GC/FID	Gas Chromatograph-Flame Ionization Detector
GC/HRMS	Gas Chromatograph/ High Resolution Mass Spectrometer
GC/MS	Gas Chromatograph/ Mass Spectrometer
GRO	Gasoline Range Organics
IC	Ion Chromatograph
ICP	Inductively Coupled Plasma-Atomic Emission Spectrometer
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
IW	Installation-Wide
KDHE	Kansas Department of Health and Environment

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

LBG	The Louis Berger Group, Inc.
LOD	Limit of Detection
LOQ	Limit of Quantitation
MAAF	Marshall Army Airfield
MDL	Method Detection Limit
MeHg	Methyl mercury
mg/kg	milligrams per kilogram
ml	milliliters
MPC	Measurement Performance Criteria
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NPL	National Priorities List
NW	Northwest
ORP	Oxidation Reduction Potential
OU 007	Operable Unit 007
PAH	Polycyclic Aromatic Hydrocarbon
PID	Photoionization Detector
PQL	Practical Quantitation Limit
PQO	Project Quality Objective
PWE	Fort Riley Directorate of Public Works – Environmental Division
QA	Quality Assurance
QAM	*Quality Assurance Manual*
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
QCSR	Quality Control Summary Report
QSM	Quality Systems Manual
RI	Remedial Investigation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SS	Site-Specific
SSHP	Site Safety and Health Plan
SVOC	Semivolatile Organic Compound

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TAL	Target Analyte List
TBD	To Be Determined
TC	Table of Contents
TestAmerica	TestAmerica West Sacramento of West Sacramento, California
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
UFP	Uniform Federal Policy
UFP-QAPP	*Uniform Federal Policy for QAPP, Parts 1, 2a, and 2b*
µg/L	micrograms per liter
µm	micrometers
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WP	Work Plan
WWI	World War I

* * * * *

INTRODUCTION

The Fort Riley Directorate of Public Works – Environmental Division (PWE) is performing the Installation Restoration Program (IRP) for the Fort Riley Military Reservation (Fort Riley) at Fort Riley, Kansas. This program, designed to identify and address potential threats to human health and the environment, has been underway for several years at Fort Riley. Numerous investigations, pilot studies, and environmental sampling events have been conducted by the United States Army Corps of Engineers (USACE) – Kansas City District (CENWK) at several sites at Fort Riley to support the IRP effort.

Based upon the results of previous investigations, Fort Riley will conduct a Remedial Investigation (RI)/Feasibility Study (FS) at the World War I (WWI) Incinerator, Northwest (NW) Camp Funston (CFI) – Operable Unit 007 (OU 007). The Louis Berger Group, Inc. (LBG) has a contract with the USACE-CENWK through which environmental investigations are being performed. LBG has subcontracted Burns and McDonnell Engineering Company, Inc. (BMcD) to prepare this Site-Specific (SS) Sampling and Analysis Plan (SAP) (further referenced as SS-SAP) for the field activities to be conducted at the CFI Site. This SS-SAP is a comprehensive document that contains information generally presented in a SAP (also referenced as a Field Sampling Plan [FSP]) and Quality Assurance Project Plan (QAPP). This SS-SAP is prepared in accordance with the Uniform Federal Policy (UFP) QAPP guidelines and contains the required UFP-QAPP worksheets.

This SS-SAP has been prepared to support the *Draft Remedial Investigation/Feasibility Study Work Plan for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas*, May 2013 (further referenced as CFI RI/FS Work Plan [WP]) prepared by LBG and BMcD for the USACE-CENWK.

This document provides a summary of various field sampling activities to be performed as well as quality assurance (QA)/quality control (QC) procedures for executing the RI/FS at the CFI Site. By providing this information under one cover, it omits the need for a separate QAPP and SAP (or FSP) and numerous cross-references between the two documents. The purpose of this SS-SAP is to establish the policies, organization, objectives, functional activities, and specific QA and QC activities for managing the project. This SS-SAP supplements the *Final Installation-Wide Sampling and Analysis Plan (Including UFP-Quality Assurance Project Plan) for the Fort Riley CERCLA Process Support at Fort Riley, Kansas,* December 2011 developed by LBG and BMcD for USACE-CENWK (further referenced as SAP-IW). Due to numerous references to the SAP-IW, a copy is provided on CD as an attachment to this SS-SAP. The scope and format of the SS-SAP and UFP-QAPP worksheets included herein were developed from

the Intergovernmental Data Quality Task Force (IDQTF) protocols outlined in *Uniform Federal Policy for QAPP, Parts 1, 2a, and 2b* ([UFP-QAPP] IDQTF, 2005).

Note, Brian Hughes has replaced Richard Van Saun as the USACE Project Manager, and all such references in the SAP-IW should be to Brian Hughes as USACE Project Manager.

SITE HISTORY AND DESCRIPTION

Fort Riley is located in north-central Kansas (see CFI RI/FS WP Figure 2-1). The Post was established in 1853 and has been owned and operated by the United States Department of the Army (DA) since that time. The Reservation is over 100,000 acres in size and includes portions of Riley, Clay, and Geary Counties. The developed areas of Fort Riley are divided into six cantonment areas: Historic Main Post, Camp Forsyth, Camp Funston, Camp Whitside, Marshall Army Airfield (MAAF), and Custer Hill.

The CFI Site is located in the western portion of the Camp Funston cantonment area within Riley County and occupies approximately two acres. The CFI Site sits approximately 300 feet southeast of the Huebner Road/Williston Point Road roundabout, directly southeast of the Union Pacific Railroad (UPRR) grade, and directly southwest of Threemile Creek. Detailed descriptions of the physical setting and site history are provided in CFI RI/FS WP Section 2.0, a site map depicting the above references is included as CFI RI/FS WP Figure 2-2, and the investigation area is shown on CFI RI/FS WP Figure 2-3.

INVESTIGATION HISTORY

Environmental investigations and sampling were performed at Fort Riley during the 1970s and 1980s. These investigations identified activities and facilities where hazardous substances had been released or had the potential to be released to the environment. Potential sources of contamination include landfills, printing, dry cleaning, furniture shops, fuels storage tanks, pesticide storage area, polychlorinated biphenyl (PCB) storage areas, and incinerators. On July 14, 1989 the United States Environmental Protection Agency (USEPA) proposed inclusion of Fort Riley on the National Priorities List (NPL) pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The USEPA included Fort Riley on the NPL, promulgated in August 1990. Fort Riley is identified by the USEPA as Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) site KS6214020756.

Several previous environmental investigations have been conducted at the CFI Site. Further details are provided in CFI RI/FS WP Sections 2.0 and 6.0.

PURPOSE

The purpose of this SS-SAP is to integrate the technical and QA/QC associated with the soil, stream sediment, surface water, and groundwater sampling performed as part of this RI/FS. The objectives of the field investigation activities for the RI/FS are presented in CFI RI/FS WP Section 1.0. The objectives of the CFI Site RI include:

- Determine the nature and extent of contamination at the CFI Site in media such as surface soil, subsurface soil, stream sediment, surface water, and groundwater;
- Quantify the nature and extent of the CFI ash at the CFI Site;
- Characterize the physical and chemical nature of contamination at the CFI Site, including fate and transport mechanisms;
- Obtain information necessary to evaluate risk, as needed, in the Baseline Risk Assessment (BLRA); and
- Obtain information necessary to evaluate remedial alternatives, as needed, in the FS.

The objective of the CFI Site BLRA is:

- Determine potential ecological and human health risk posed by contamination at the CFI Site.

The objective of the CFI Site FS is:

- Develop and evaluate remediation alternatives, as appropriate.

CFI RI/FS WP Section 6.0 presents the evaluation of the existing CFI Site data and the rationale for additional sampling needed to complete the RI/FS.

ORGANIZATION OF QAPP ELEMENTS

This SS-SAP has been prepared by BMcD as part of the supplemental project planning documents for a RI/FS at the CFI Site. This SS-SAP is organized as follows:

Main Body of the SS-SAP:

- Introduction

- UFP-QAPP Format Worksheets and Supporting Documentation
  (including discussions for field standard operating procedures (SOPs) and laboratory information)
- References

The main UFP-QAPP Worksheet details are provided in the SAP-IW prepared for Fort Riley. The majority of the required SAP information is provided in the SAP-IW. As such, a copy is provided on CD as an attachment to this report.

* * * * *

QAPP Worksheet #1
(UFP-QAPP Manual Section 2.1)
Title and Approval Page

Site Name/Project Name: CFI RI/FS
Site Location: CFI – OU 007, Fort Riley, Kansas

Document Title: ***Draft Site-Specific Sampling and Analysis Plan (Including Site-Specific UFP-Quality Assurance Project Plan) for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas***

Lead Organization: **USACE-CENWK**

Preparer's Name and Organizational Affiliation: Shauna Lawrence, BMcD

Preparer's Address, Telephone Number, & E-Mail Address: 9400 Ward Pkwy, Kansas City, MO 64114
Shauna Lawrence: (816) 822-3940 / slawrence@burnsmcd.com

Preparation Date (Day/Month/Year): 07/July/2013

Investigative Organization's Program Manager / Date:_____
Signature
Printed Name/Organization: Tracy Cooley, BMcD

Investigative Organization's Project QC Coordinator / Date:_____
Signature
Printed Name/Organization: Martha Hildebrandt, BMcD

Primary Contractor's Project Manager / Date:_____
Signature
Printed Name/Organization: Dennis McGrath, LBG

Lead Organization's Project Manager / Date:_____
Signature
Printed Name/Organization: Brian Hughes, USACE-CENWK

Fort Riley PWE Project Manager / Date:_____
Signature
Printed Name/Organization: Andrea Austin, Fort Riley PWE

United States Army Environmental Command (USAEC) Environmental Restoration Manager / Date:_____
Signature
Printed Name/Organization: Judith Keith, USAEC

Kansas Department of Health and Environment (KDHE) Project Manager / Date:_____
Signature
Printed Name/Organization: Travis Daneke, KDHE

USEPA Project Manager/Date:_____
Signature
Printed Name/Organization: Amer Safadi, USEPA-Region 7

Approval Signature/Date:_____
Signature

Printed Name/Title:
Approval Authority:

Other Approval Signature/Date:_____
Signature

Printed Name/Title:
Approval Authority:

Document Control Numbering System: See SS-SAP Cover and Worksheet #3

* * * * *

QAPP Worksheet #2
(UFP-QAPP Manual Section 2.2.4)
QAPP Identifying Information

Site Name: CFI – OU 007

Project Name: WWI Incinerator, NW Camp Funston (CFI) – Operable Unit (OU) 007 RI/FS

Site Number/Code: FTRI-074

Operable Units: OU 007

Contractor Name: LBG and BMcD

Contract Number: W912DQ-08-D-0017

Contract Title: *Remedial Investigation/Feasibility Study (RI/FS) and Related Activities Camp Funston World War I Incinerator (OU 007) Fort Riley, Kansas*

1. **Identify guidance used to prepare QAPP:** *Uniform Federal Policy for QAPP, Parts 1, 2a, and 2b, Final, Version 1, March 2005* (IDQTF, 2005)

2. **Identify regulatory program:** CERCLA

3. **Identify approval entity:** USACE-CENWK

4. **The QAPP is (select one):** Generic Project-Specific

5. **List dates of scoping sessions that were held:** See SS-SAP Worksheet #9

6. **List dates and titles of QAPP documents written for previous site work, if applicable:**

Title	Approval Date
Final Installation-Wide Sampling and Analysis Plan for Environmental Investigations at Fort Riley, Kansas, Quality Assurance Project Plan (QAPP) (USACE, 2004)	February 2004

7. **List organizational partners (stakeholders) and connection with lead organization:**
   USAEC – Legal Review and Concurrence
   KDHE – Review and Concurrence
   USEPA-Region 7 – Review and Concurrence

8. **List data users:** USACE-CENWK, LBG, BMcD, KDHE, USEPA-Region 7, USAEC, and Fort Riley PWE

9. **If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below:**

   - Section 5.3 – Streamlining Data Review is not applicable. No streamlining of the data review process is being performed.

QAPP Worksheet #2
QAPP Identifying Information
(continued)

Circle SAP elements and required information that are not applicable to the project. Provide an explanation in the SAP.

Referenced documents include:

Site-Specific WP = ***Draft Remedial Investigation/Feasibility Study Work Plan for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LGB-BMcD, July 2013)*** **(CFI RI/FS WP)**

Installation-Wide (IW) Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) = ***Final Installation-Wide Accident Prevention Plan and Site Safety and Health Plan for Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LBG-BMcD, January 2012)*** **(IW-APP/SSHP)**

Draft Addendum No. 2 to the Installation-Wide Accident Prevention Plan for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LBG-BMcD, July 2013)

Site-Specific Investigation-Derived Waste (IDW) Plan = ***Draft Site-Specific Investigative-Derived Waste Management Plan for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LBG-BMcD, July 2013)*** **(SS-IDW)**

Installation-Wide IDW Plan = ***Installation-Wide Investigative-Derived Waste Management Plan for Environmental Investigations at Fort Riley, Kansas (BMcD), 2003)*** **(IW-IDW)**

Site-Specific Quality Control Plan (QCP) = ***Final Quality Control Plan for Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LBG-BMcD, March 2013)*** **(SS-QCP)**

Site-Specific SAP = ***Draft Site-Specific Sampling and Analysis Plan (Including Site-Specific UFP-Quality Assurance Project Plan) for RI/FS Environmental Investigations for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas (LBG-BMcD, July 2013)*** **(SS-SAP)**

Installation-Wide SAP = ***Final Installation-Wide Sampling and Analysis Plan (Including UFP-Quality Assurance Project Plan) for the Fort Riley CERCLA Process Support at Fort Riley, Kansas (LBG-BMcD, December 2011)*** **(SAP-IW)**

Two Phase Approach = ***Final Technical Memorandum, Proposed Two-Phase Approach for Field Sampling Activities, for RI/FS Investigations, for the WWI Incinerator, NW Camp Funston (CFI) – Operable Unit 007 at Fort Riley, Kansas, May 2013***

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Referenced Documents	QAPP Worksheet # or Page #	Required Information
Project Management and Objectives			
2.1 Title and Approval Page		SS QAPP #1	- Title and Approval Page
2.2 Document Format and Table of Contents (TC) 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.3 QAPP Identifying Information		SS QAPP TC-1 to TC-6 #2 and #3	- Table of Contents - QAPP Identifying Information - Document Control Numbering
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet		SS QAPP #3 and #4-1 to 4-5	- Distribution List - Project Personnel Sign-Off Sheet
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification		IW QAPP #5 through #8	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	CFI RI/FS WP Sections 2.0, 4.0, and 6.0, and Figure 7.1	SS QAPP #9 and #10	- Project Scoping Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)
2.6 Project Quality Objectives (PQOs) and Measurement Performance Criteria (MPC) 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	CFI RI/FS WP Sections 1.0, 4.0, and 6.0, and Figure 7.1	SS QAPP #11 and #12	- Site-Specific PQOs - MPC Table
2.7 Secondary Data Evaluation	CFI RI/FS WP Section 6.0	SS QAPP #13	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	CFI RI/FS WP Section 6.0 and Figures 6-1	SS QAPP #14 and #16	- Summary of Project Tasks - Reference Limits and Evaluation Table

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Referenced Documents	QAPP Worksheet # or Page #	Required Information
	through 6-5 and 7-1	IW QAPP #15	- Project Schedule/Timeline Table
Measurement/Data Acquisition			
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation	CFI RI/FS WP Sections 4.0 and 6.0, and Figures 6-1 through 6-5	SS QAPP #17, #18, and #20 IW QAPP #19, #21, and #22	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table
3.1.2.3 Equipment/ Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures			- Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures		IW QAPP #23, #24, and #25	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody		IW QAPP #26 and #27	- Sample Handling Flow Diagram - Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Example Chain-of-Custody (COC) Form and Seal
3.4 Quality Control Samples		IW QAPP	- QC Samples Table

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Referenced Documents	QAPP Worksheet # or Page #	Required Information
3.4.1 Sampling QC Samples 3.4.2 Analytical QC Samples		#28	- Screening/Confirmatory Analysis Decision Tree
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control		IW QAPP #29 and #30	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs
Assessment/Oversight			
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses		IW QAPP #31 and #32	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table
4.2 QA Management Reports		IW QAPP #33	- QA Management Reports Table
4.3 Final Project Report			
Data Review			
5.1 Overview			
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities		IW QAPP #34 through #37	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining	Not applicable	Not Applicable	Not applicable. No streamlining of the data review process is being performed.

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QAPP Worksheet #3
(UFP-QAPP Manual Section 2.3.1)
Distribution List

The distribution list for controlled copies of the SS-SAP is maintained by and updated by BMcD as the SS-SAP preparation organization. Controlled copies of the SS-SAP are assigned to personnel within each project organization. Recipients of controlled copies are provided with all revisions to the SS-SAP and are responsible for removing all outdated materials from circulation within their organization. Personnel responsible for controlled copies of the document are responsible for distributing SS-SAP updates and revisions to personnel within their organization. Project team members will have access to controlled copies of the document through the project managers listed here. Personnel with access to the SS-SAP include, but are not limited to: Program Manager, Project Manager, Project Engineer, Project Technical Lead, Project Chemist, QA Officer, QC Coordinator, Field Site Manager (FSM), field team members, and/or laboratory staff.

SS-SAP Recipients	Title	Organization	Telephone Number	Fax Number	E-Mail Address	Document Control Number
Tracy Cooley Ed Lindgren	Program Manager Project Manager	BMcD	816-822-3369 816-822-3595	816-822-3494	tcooley@burnsmcd.com elindgren@burnsmcd.com	SW-SAP-001
Dennis McGrath	Project Manager	LBG	914-798-3711	914-592-1734	dmcgrath@louisberger.com	SW-SAP-002
Brian Hughes	Project Manager	USACE-CENWK	816-389-3429	816-389-2023	brian.t.hughes@usace.army.mil	SS-SAP-003
Andrea Austin	Project Manager	Fort Riley PWE	785-239-8536	785-239-8535	andrea.l.austin12.civ@mail.mil	SW-SAP-004
Judith Keith	Environmental Restoration Manager	USAEC	210-466-1700	--	judith.m.keith.civ@mail.mil	SW-SAP-005
Travis Daneke	Project Manager	KDHE	785-296-6378	785-296-4823	tdaneke@kdheks.gov	SW-SAP-006
Amer Safadi	Project Manager	USEPA-Region 7	913-551-7418	913-551-7765	safadi.amer@epamail.epa.gov	SW-SAP-007
Karen Dahl	Project Manager	TestAmerica West Sacramento	916-374-4384	916-372-1059	karen.dahl@testamericainc.com	SW-SAP-008
Tiffany Stillwater	Project Manager	Brooks Rand Labs	206-632-6206	206-632-6017	tiffany@brooksrand.com	SW-SAP-009

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QAPP Worksheet #4
(UFP-QAPP Manual Section 2.3.2)
Project Personnel Sign-Off Sheet

Worksheet #4-1 USACE-CENWK

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Brian Hughes	Project Manager	816-389-3429		
Timothy R. Shepherd	Project Chemist	816-389-3920		

Worksheet #4-2 LBG

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Dennis McGrath	Project Manager	914-798-3711		

Worksheet #4-3 BMcD

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Tracy Cooley	Program Manager	816-822-3369		
Ed Lindgren	Project Manager	816-822-3595		
Shauna Lawrence	Project Chemist	816-822-3940		
Martha Hildebrandt	Project QC Manager	816-822-3891		
Justin Carter	Field Site Manager	816-823-7104		
Eric Wenger	Safety and Health Manager	816-822-3894		
To Be Assigned	Additional Field Team Members		When assigned, project team members will be required to sign that they have read applicable sections of the SS-SAP.	Project team members must read applicable sections of the SS-SAP prior to participating in the project.

Worksheet #4-4 Fort Riley PWE

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Andrea Austin	Project Manager	785-239-8536		

Worksheet #4-5 USAEC

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Judith Keith	Environmental Restoration Manager	210-466-1700		

Worksheet #4-6 KDHE

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Travis Daneke	Project Manager	785-296-6378		

Worksheet #4-7 USEPA-Region 7

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Amer Safadi	Project Manager	913-551-7825		

Worksheet #4-8 TestAmerica West Sacramento

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Karen Dahl	Project Manager	916-374-4384		

Worksheet #4-9 Brooks Rand Labs

Key project personnel from each organization should sign copies of this form to indicate that they have read the applicable SS-SAP sections and will perform the tasks as described. Each organization will forward signed sheets to BMcD for inclusion in the project file.

Project Personnel	Title	Telephone Number	Signature	Date SS-SAP Read E-Mail Receipt
Tiffany Stillwater	Project Manager	206-632-6206		

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QAPP Worksheet #5
(UFP-QAPP Manual Section 2.4.1)
Project Organizational Chart

SAP-IW Worksheets #5 and #7 discuss the QC teams, roles, and responsibilities within BMcD and LBG. Also included in SAP-IW Worksheet #5 is a discussion of the regulatory organizations. Project organization, teams, roles, and responsibilities are discussed in detail in CFI RI/FS WP Section 8.0. A project organizational chart is presented on CFI RI/FS WP Figure 8-1.

TestAmerica West Sacramento of West Sacramento, California (TestAmerica) is the contract laboratory for the majority of analyses of soil, stream sediment, surface water, and/or groundwater samples for this project (see SS-SAP Worksheet #11 for a list of analyses to be performed by TestAmerica). The address for TestAmerica is listed below.

TestAmerica West Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
Phone: 916-374-4384
POC: Karen Dahl

Brooks Rand Labs, LLC of Seattle, Washington (BRL) is the primary analytical laboratory for the analysis of soil, stream sediment, surface water, and groundwater samples for methyl mercury (MeHg). The address for BRL is listed below.

Brooks Rand Labs, LLC
3958 6th Ave NW
Seattle, WA 98107
Phone: 206-632-6206
POC: Tiffany Stillwater

As indicated in the USACE-CENWK Scope of Work, the analytical laboratories performing sample analysis are required to be certified by the National Environmental Laboratory Accreditation Program (NELAP). In addition, it is required to submit water and soil/sediment samples to laboratories that are accredited in compliance with the most recent Department of Defense (DoD) Quality Systems Manual (QSM) Final Version 4.2 (DoD, 2010). Both TestAmerica and BRL are accredited DoD Environmental Laboratory Accreditation Program (ELAP) laboratories and are QSM compliant. Copies of their DoD certifications are included in Appendix A of this SS-SAP. The organizational structure and responsibilities, including an organizational chart, are described in each laboratory's Quality Assurance Manual (QAM) (see SS-SAP Appendix A).

Additionally, the state of Kansas certification for TestAmerica is included in SS-SAP Appendix A. BRL is not certified in the state of Kansas at the time of SS-SAP preparation; however, through National Environmental Laboratory Accreditation Conference (NELAC) reciprocity, certification can be obtained within several weeks. BRL will have Kansas certification in place prior to the sampling start date for the required sample matrices and analytical methods for the project tasks.

In some instances, a sister TestAmerica location (i.e. TestAmerica Denver) may be utilized for one or more analyses due to analytical certification. In these cases, the appropriate analytical manual(s), certification(s), and SOP(s) are provided as necessary in the SS-SAP Appendix A. All samples are planned to be sent to TestAmerica West Sacramento in the sample shipment. TestAmerica West Sacramento will then forward the samples to the appropriate sister lab, as needed. All sample results are planned to be reported by TestAmerica West Sacramento within one laboratory data package unless otherwise noted.

Note, the SAP-IW includes TestAmerica QAMs, DoD and Kansas certifications, and laboratory SOPs; however, most of these items have been updated and/or revised since preparation of the SAP-IW. As such, these TestAmerica laboratory documents (including all required laboratory SOPs) are included in Appendix A of the SS-SAP. If laboratory reporting limits, QC limits, instrument calibration procedures, and/or analytical preservation requirements for analyses to be performed by TestAmerica have been revised, then they will be included in the subsequent SS-SAP worksheets. If the information has not revised, then the SAP-IW will be referenced where necessary. Because BRL was not included as a primary laboratory in the SAP-IW, the subsequent SS-SAP worksheets will include the noted laboratory analytical information for BRL.

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QAPP Worksheet #6
(UFP-QAPP Manual Section 2.4.2)
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (timing, pathways, etc.)
A discussion of the communication pathways for the CFI Site RI/FS is presented on SAP-IW Worksheet #6. Generally, BMcD and LBG personnel will communicate primarily with the USACE-CENWK Project Manager. Communication with other government entities (KDHE, etc.) will be coordinated by USACE-CENWK. Questions from the general public regarding project activities will be directed to the USACE-CENWK Project Manager.				

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QAPP Worksheet #7
(UFP-QAPP Manual Section 2.4.3)
Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Resumes are located in the offices of each organization and are available upon request. Responsibilities of team members are also presented on SAP-IW Worksheet #5. SAP-IW Worksheet #7 provides a summary of personnel titles, organizational affiliations, responsibilities, and education and experience qualifications of project team members. Note, Brian Hughes has replaced Richard Van Saun as the USACE Project Manager, and all such references in the SAP-IW should be to Brian Hughes as USACE Project Manager.				

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QAPP Worksheet #8
(UFP-QAPP Manual Section 2.4.4)
Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
SAP-IW Worksheet #8 presents training requirements, where applicable, for project team members. Also included is a discussion of required certifications for the primary laboratories. SS-SAP Attachment A includes copies of the laboratories' required certifications, where applicable. Note that the required certifications for TestAmerica are also included in SAP-IW Appendix A; however; these certifications were expired at the time of SS-SAP preparation. Therefore, the updated certifications for TestAmerica are included in SS-SAP Attachment A.						

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QAPP Worksheet #9
(UFP-QAPP Manual Section 2.5.1)
Project Scoping Session Participants Sheet

Project Name: CFI RI/FS **Projected Date(s) of Sampling:** See CFI RI/FS WP Figure 7-1 **Project Manager:** Brian Hughes, USACE-CENWK				**Site Name:** CFI – OU 007 **Site Location:** CFI, Fort Riley, Kansas	
Date of Session: not applicable **Scoping Session Purpose:** not applicable					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
The CFI RI/FS Project was scoped via telephone conference calls with all interested parties and through the development of the Two-Phase Approach.					

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QAPP Worksheet #10
(UFP-QAPP Manual Section 2.5.2)
Problem Definition

PROBLEM DEFINITION, SITE HISTORY, AND BACKGROUND

A site history and description is provided in the introduction to this SS-SAP. Additional background information is provided in CFI RI/FS WP Sections 2.0 and 6.0.

This RI is being conducted to further investigate the CFI Site, for which the nature and extent of contamination was not fully defined in the previous environmental investigations.

The objectives of the CFI Site RI are:

- Determine the nature and extent of contamination at the CFI Site in media such as surface soil, subsurface soil, stream sediment, surface water, and groundwater;
- Quantify the nature and extent of the CFI ash at the CFI Site;
- Characterize the physical and chemical nature of contamination at the CFI Site, including fate and transport mechanisms;
- Obtain information necessary to evaluate risk, as needed, in the BLRA;
- Refine the conceptual site model (CSM); and
- Obtain information necessary to evaluate remedial alternatives, as needed, in the FS.

The objective of the CFI Site BLRA is:

- Determine potential ecological and human health risk posed by contamination at the CFI Site.

The objective of the CFI Site FS is:

- Develop and evaluate remediation alternatives, as appropriate.

The problem to be addressed by the project:

See CFI RI/FS WP Section 4.0. Discussion is provided for the Data Quality Objectives (DQOs) established to clarify the project objectives, define the type of data needed to meet project objectives, and establish limits for the quantity and quality of data needed to support project decisions.

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QAPP Worksheet #11
(UFP-QAPP Manual Section 2.6.1)
Project Quality Objectives / Systematic Planning Process Statements

Project quality objectives (PQOs) define the type, quantity, and quality of data that are needed to answer questions and support environmental decision-making. PQOs are presented as both qualitative and quantitative statements. CFI RI/FS WP Section 4.0 presents a detailed discussion of the DQOs for the investigation.

Who will use the data?

Data users include project team members from USACE-CENWK, LBG, BMcD, Fort Riley PWE, USAEC, KDHE, and USEPA-Region 7.

What will the data be used for?

The data gathered during the RI/FS will be used to determine the nature and extent of contamination, to assess potential risks to human health and the environment, to develop/screen remedial alternatives, and to, as needed, design remediation approaches. Further details of the objectives of the investigations are discussed in CFI RI/FS WP Section 1.0.

What types of data are needed?

The CFI RI/FS WP supports an iterative field approach for data collection. CFI RI/FS WP Section 4.0 discusses the data needs and work plan approach for the CFI Site in further detail. An evaluation of existing data has been performed to identify potential data gaps for the CFI Site. Additional data needs for the CFI Site include:

- Chemicals of potential concern (COPC) concentrations for the following sample matrices:
    - Background soil
    - Surface and subsurface soil
    - Stream sediment
    - Surface water
    - Groundwater
- Vertical and horizontal delineation of groundwater contamination at the CFI Site
- Installation of monitoring wells screened within the alluvial aquifer

- Slug tests to evaluate hydrogeologic characteristics of the alluvial aquifer
- Geochemical data including water quality parameters

This additional data is needed to determine nature and extent of contaminants present, evaluate fate and transport of the contaminants, characterize risk to human health and the environment, evaluate the need for remediation, determine remediation methods, and design remediation systems. Details of the existing data and data gaps are presented in Section 6.0 of this RI/FS WP.

The following analyses will be performed by TestAmerica for the CFI Site RI/FS:

- Volatile Organic Compounds (VOCs): benzene, toluene, ethylbenzene, and total xylenes (BTEX)
- Total Petroleum Hydrocarbons (TPH) – Gasoline Range Organics (GRO)
- TPH – Diesel Range Organics (DRO)
- Target Analyte List (TAL) metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc
- Semi-Volatile Organic Compounds (SVOCs): phenols and polycyclic aromatic hydrocarbons (PAHs)
- Dioxins/furans
- Water quality laboratory parameters: alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and total organic carbon (TOC)

SAP-IW Worksheet #19 and SS-SAP Worksheet #20 present the analytical methods for these analyses. In addition, water quality field parameters of temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP) will be measured and recorded in the field during all monitoring well groundwater sampling events.

The following analysis will be performed by BRL for the CFI Site RI/FS:

- Methyl mercury (MeHg)

SS-SAP Worksheets #19 and #20 present the analytical method for this analysis.

CFI RI/FS WP Section 6.0 contains a detailed description of planned sampling analyses and locations.

What is the matrix of interest?

Soil (surface, ash deposit, and subsurface), stream sediment, surface water, and groundwater are the matrices of interest in the CFI Site RI/FS.

How "good" do the data need to be in order to support the environmental decision?

Data are being collected to assess the potential for human exposure regarding the soil, sediment, surface water, and groundwater pathway(s). Further discussion of data quality is presented in the SAP-IW Worksheet #12, Measurement Performance Criteria Table and Worksheet #15, Reference Limits and Evaluation Table.

How much data are needed?

The planned number of soil, stream sediment, surface water, and/or groundwater samples as well as the sampling rationale are provided in CFI RI/FS WP Section 6.0. Field investigation activities could be modified as field progress and analytical results become available. This could result in the addition or deletion of sampling locations or lines. Any deviations from the CFI RI/FS WP will be discussed with and approved by the USACE-CENWK Project Manager prior to implementation.

Where, when, and how should the data be collected/generated?

To fill the data gaps, the following two-phased sampling approach is planned.

Activities to support Phase I of the RI/FS at the CFI Site include:

- Collection of background soil samples from an off-site location with an analogous soil type and depositional environment;
- Collection of surface soil samples from overland flow drainage areas;
- Collection of stream sediment samples from Threemile Creek;
- Collection of surface water samples from Threemile Creek;
- Collection of surface and subsurface soil samples;
- Collection of direct-push groundwater samples, if present; and
- Data validation, evaluation, and screening to determine if and/or which analytes will be eliminated from the Phase II sampling activities.

Field activities to support Phase II of the RI/FS at the CFI Site include:

- Collection of additional surface soil samples from overland flow drainage areas near the trap/skeet range;
- Collection of additional stream sediment samples from Threemile Creek upgradient of the CFI Site;
- Collection of additional surface water samples from Threemile Creek upgradient of the CFI Site;
- Collection of surface and subsurface soil samples;
- Collection of direct-push groundwater samples, if present;
- Installation and development of monitoring wells;
- Quarterly collection of groundwater samples from newly installed monitoring wells; and
- Characterization of hydrogeologic properties of the aquifer via slug testing.

If, after completion of the field investigation, it is determined that additional field investigation activities are needed to fully define the nature and extent of contamination, then the following additional field work may be proposed:

- Collection of soil, stream sediment, surface water, and/or groundwater samples;
- Installation of monitoring wells;
- Monitoring well sampling; and
- Slug testing.

Samples will be collected from the locations indicated in CFI RI/FS WP Section 6.0 (including Figures 6-1 through 6-5). Field work is tentatively scheduled to begin in November 2013 (see CFI RI/FS WP Figure 7-1). The SOPs in SAP-IW Appendix B present information regarding the various sample collection techniques and other field operations that may be used.

A summary of the project schedule is provided on CFI RI/FS WP Figure 7-1.

Who will collect and generate the data?

Information regarding collection and generation of data is provided in SAP-IW Worksheet #11.

How will the data be reported?

Information regarding reporting of the data is provided in SAP-IW Worksheet #11.

Project reporting requirements are provided on CFI RI/FS WP Figure 7-1. Planned reports for the the RI/FS include:

- Daily Quality Control Reports (DQCRs)
- Monthly Progress Reports
- Quality Control Summary Reports (QCSRs)
- Preliminary Exposure Pathway Analysis Report
- Pathway Analysis Report
- RI Report
- BLRA Report

How will the data be archived?

Information regarding data archiving is provided in SAP-IW Worksheet #11.

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QAPP Worksheet #12
(UFP-QAPP Manual Section 2.6.2)
Measurement Performance Criteria Table

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S & A)
Table 12-1 of this SS-SAP provides the measurement performance criteria (MPC) for the MeHg analysis planned for soil, stream sediment, surface water, and/or groundwater samples associated with the sampling activities to be conducted at the CFI Site. Worksheet #12 in the SAP-IW provides the MPC (where applicable) for the following analyses planned for soil, stream sediment, surface water, and/or groundwater samples associated with the RI/FS: BTEX, TPH-GRO, TPH-DRO, TAL metals, SVOCs, dioxins/furans, and/or water quality laboratory parameters. Additionally, MPC discussion including precision, accuracy/bias, quantitation limits, representativeness, comparability, and completeness is provided in SAP-IW Worksheet #12.					

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QAPP Worksheet #13
(UFP-QAPP Manual Section 2.7)
Secondary Data Criteria and Limitations Table

Secondary Data	Major Data Sources (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
CFI RI/FS WP Section 6.0 discusses a detailed review of the previous investigations performed at the CFI Site.				

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QAPP Worksheet #14
(UFP-QAPP Manual Section 2.8.1)
Summary of Project Tasks

SAMPLING TASKS:

Soil, stream sediment, surface water, and/or groundwater samples will be collected from various locations at the CFI Site (see CFI RI/FS WP Figures 6-1 through 6-5). The following two-phased sampling approach is planned. These sampling tasks are described in detail in CFI RI/FS WP Section 6.0.

Phase I Sampling Activities

- **Background Soil** – Twelve (12) hand auger borings (BG-01 through BG-12) will be advanced for background concentration determination from off-site locations with an analogous soil type with four (4) of the hand auger borings being from each depositional environment (upland terrace, floodplain slope, and Kansas River floodplain) (see CFI RI/FS WP Figure 6-1). These hand auger borings will be continuously sampled, using a stainless-steel hollow core-barrel hand auger sampler, from ground surface to 4 feet (ft) below ground surface (bgs). Hand auger borings will be performed in accordance to SOP #103 included in SOP Series 100 in SAP-IW Appendix B. Two soil samples will be collected from each hand auger boring at depth intervals of 0 ft to 0.5 ft bgs and 3 ft to 4 ft bgs. The field geologist will prepare a lithographic log of each hand auger boring in accordance with SOP #508 included in SOP Series 500 in the SAP-IW Appendix B. See CFI RI/FS WP Table 6-1 for specific sampling and labeling requirements for background soil sampling activities.

- **Surface Soil and Stream Sediment** – Five (5) surface soil samples (SS-01 through SS-05) will be collected from the overland flow drainage area that drains into Threemile Creek (see CFI RI/FS WP Figure 6-2). These surface soil samples will be collected using hand tools (i.e. shovel, trowel, etc.) from ground surface to 0.5-ft bgs. The field geologist will briefly describe the lithology of each surface soil sample in the field logbook in accordance with SOP #508 included in SOP Series 500 in the SAP-IW Appendix B. Surface soil samples will be collected in accordance to SOP #102 included in SOP Series 100 in SAP-IW Appendix B.

  Three (3) stream sediment samples (SD-01 through SD-03) will be collected from Threemile Creek (see CFI RI/FS WP Figure 6-2). One (1) stream sediment sample will be collected upgradient of where the overland flow area drains into Threemile Creek, one (1) stream sediment sample will be collected adjacent to where the overland flow area that drains into Threemile Creek, and one (1) stream sediment sample will be collected down gradient of where the overland

flow area drains into Threemile Creek. These stream sediment samples will be collected from the bottom of Threemile Creek using a long-handled Teflon ladle. Stream sediment samples will be collected from the sediment material immediately below the water approximately mid-stream of Threemile Creek. The field geologist will briefly describe the lithology of each stream sediment sample in the field logbook in accordance with SOP #508 included in SOP Series 500 in the SAP-IW Appendix B. Stream sediment samples will be collected in accordance to SOP #101 included in SOP Series 100 in SAP-IW Appendix B.

See CFI RI/FS WP Table 6-2 for specific sampling and labeling requirements for Phase I surface soil and stream sediment sampling activities.

- **Surface Water** – Three (3) surface water samples (SW-01 through SW-03) will be collected from Threemile Creek (see CFI RI/FS WP Figure 6-2). These surface water samples will be collected at the same locations described above where stream sediment samples were collected. These surface water samples will be collected from the surface of the Threemile Creek using a long-handled Teflon ladle. Surface water samples will be collected in accordance with SOP #208 included in SOP Series 200 in the SAP-IW Appendix B. The depth of each sample collected will be recorded in the field logbook along with pH, temperature, and specific conductivity. Surface water samples collected for TAL metals will be filtered in the field prior to shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis. See CFI RI/FS WP Table 6-3 for specific sampling and labeling requirements for Phase I surface water sampling activities.

  Surface water and stream sediment samples will be co-located. During sampling, samples will be first collected from the down gradient location moving upgradient. Due to the surface water and stream sediment samples being co-located the surface water sample will be collected prior to the stream sediment sample.

- **Direct-Push Soil** – Seven (7) direct-push borings (DP-01 through DP-07) will be advanced along sampling transect lines down the floodplain slope and onto the Kansas River floodplain (see CFI RI/FS WP Figure 6-3). These direct-push borings will be continuously sampled, using a 2-inch Macrocore® sampler, from ground surface to the bottom of the boring. Soil sampling using direct-push technology will be performed in accordance to SOP #103 included in SOP Series 100 in SAP-IW Appendix B. In general, four (4) soil samples will be collected from each direct-push boring. One (1) soil sample will be collected from each of the following targeted lithographic zones: surface soil zone, ash deposit zone, soil below ash zone, and soil 6 ft to 10 ft below ash

zone (see CFI RI/FS WP Section 6.0 for a detailed description of each targeted lithographic zones). If there are direct-push borings in which there is not a visually discernible ash deposit zone present, the BMcD Project Manager and USACE-CENWK Project Manager will be contacted to determine the number of samples and sampling intervals that will be collected.

The field geologist will prepare a lithologic log of each direct-push boring per SOP #508 included in SOP Series 500 in the SAP-IW Appendix B and will screen the soil from ground surface to the bottom of borehole using a photoionization detector (PID). The field geologist will use the PID screening results, visual staining (if present), and best judgment in selecting where to collect soil samples within these zones. The field geologist will also have the discretion to collect additional samples if elevated PID screening results are encountered or staining are observed. Some sample locations located on the floodplain slope may be inaccessible with a direct-push rig due to the steepness of the slope. At these locations soil samples will be collected from the lithographic zones using a stainless-steel, hollow core-barrel, hand auger sampler.

See CFI RI/FS WP Table 6-4 for specific sampling and labeling requirements for Phase I direct-push soil sampling activities.

Phase I soil sampling locations are biased towards sample collection within or very near the areas where incinerator ash has been mapped during previous investigations. However, two (2) direct-push borings (DP-06 and DP-07) are located on the Kansas River floodplain. The field geologist will have the authority to adjust sampling locations, as appropriate based on field screening, observations made during soil logging, and site conditions.

- **Direct-Push Groundwater** – Following the collection of the direct-push soil samples, five (5) selected direct-push borings (DP-08 through DP-12) will be advanced to the water table. The groundwater samples will be collected along the sampling transect lines; along the flood plain slope, at the toe of the floodplain, and on the Kansas River floodplain (see CFI RI/FS WP Figure 6-3). These groundwater samples will be collected at the proposed groundwater sample locations based upon the field geologists observations and discussions with the BMcD Project Manager. Groundwater sampling using direct-push technology will be performed in accordance to SOP #209 included in SOP Series 200 in the SAP-IW Appendix B. A single groundwater sample will be collected from each of these selected direct-push borings. Groundwater samples collected for TAL metals will be filtered in the field prior to shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

See CFI RI/FS WP Table 6-4 for specific sampling and labeling requirements for Phase I direct-push groundwater sampling activities.

Phase II Sampling Activities

- **Surface Soil and Stream Sediment** – Based upon the Phase I data evaluation, if it appears that contaminants from either the wastewater plant or the trap/skeet range are impacting surface soil and/or stream sediment within or adjacent to Threemile Creek, then additional samples of those matrices will be collected.

  Three (3) surface soil samples (SS-06 through SS-08) will be collected from the overland flow drainage area that drains into Threemile Creek (see CFI RI/FS WP Figure 6-4). These surface soil samples will be collected using hand tools (i.e. shovel, trowel, etc.) from ground surface to 0.5 ft bgs. The field geologist will briefly describe the lithology of each surface soil sample in the field logbook in accordance with SOP #508 included in SOP Series 500 in the SAP-IW Appendix B. Surface soil samples will be collected in accordance to SOP #102 included in SOP Series 100 in SAP-IW Appendix B.

  Three (3) stream sediment samples (SD-04 through SD-06) will be collected from Threemile Creek (see CFI RI/FS WP Figure 6-4). One (1) stream sediment sample will be collected upgradient of where the overland flow from the trap/skeet range drains into Threemile Creek, one (1) stream sediment sample will be collected adjacent to where the overland flow from the trap/skeet range drains into Threemile Creek, and one (1) stream sediment sample will be collected down gradient of where the overland flow from the trap/skeet range drains into Threemile Creek. These stream sediment samples will be collected from the bottom of Threemile Creek using a long-handled Teflon ladle. Stream sediment samples will be collected from the sediment material immediately below the water approximately mid-stream of Threemile Creek. The field geologist will briefly describe the lithology of each stream sediment sample in the field logbook in accordance with SOP #508 included in SOP Series 500 in the SAP-IW Appendix B. Stream sediment samples will be collected in accordance to SOP #101 included in SOP Series 100 in SAP-IW Appendix B.

  See CFI RI/FS WP Table 6-5 for specific sampling and labeling requirements for Phase II surface soil and stream sediment sampling activities.

- **Surface Water** – Based upon the Phase I data evaluation, if it appears that contaminants from either the wastewater plant or the trap/skeet range are impacting surface water within or adjacent to Threemile Creek, then additional surface water samples will be collected.

  Three (3) surface water samples (SW-04 through SW-06) will be collected from Threemile Creek (see CFI RI/FS WP Figure 6-4). These surface water samples will be collected at the same locations described above where stream sediment samples were collected. These surface water samples will be collected from the surface of the Threemile Creek using a long-handled Teflon ladle collecting water. Surface water samples will be collected in accordance with SOP #208 included in SOP Series 200 in SAP-IW Appendix B. The depth of each sample collected will be recorded in the field logbook along with pH, temperature, and specific conductivity. Surface water samples collected for TAL metals will be filtered in the field prior to shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis. See CFI RI/FS WP Table 6-6 for specific sampling and labeling requirements for Phase II surface water sampling activities.

  Surface water and stream sediment samples will be co-located. During sampling, samples will be first collected from the down gradient location moving upgradient. Due to the surface water and stream sediment samples being co-located the surface water sample will be collected prior to the stream sediment sample.

- **Direct-Push Soil** – Twelve (12) direct-push borings (DP-13 through DP-24) will be advanced along the sampling transect lines down the floodplain slope and onto the Kansas River floodplain (see CFI RI/FS WP Figure 6-5). These direct-push borings will be continuously sampled, using a 2-inch Macrocore® sampler, from ground surface to the bottom of the boring. Soil sampling using direct-push technology will be performed in accordance to SOP #103 included in SOP Series 100 in SAP-IW Appendix B. In general, four (4) soil samples will be collected from each direct-push boring. One (1) soil sample will be collected from each of the following targeted lithographic zones: surface soil zone, ash deposit zone, soil below ash zone, and soil 6 ft to 10 ft below ash zone (see CFI RI/FS WP Section 6.0 for a detailed description of each targeted lithographic zones). If there are direct-push borings in which there is not a visually discernible ash deposit zone present, the BMcD Project Manager and USACE-CENWK Project Manager will be contacted to determine the number of samples and sampling intervals that will be collected.

  The field geologist will prepare a lithologic log of each direct-push boring per SOP #508 included in SOP Series 500 in the SAP-IW Appendix B and will screen the soil from ground surface to the

bottom of borehole using a PID. The field geologist will use the PID screening results, visual staining (if present), and best judgment in selecting where to collect soil samples within these zones. The field geologist will also have the discretion to collect additional samples if elevated PID screening results are encountered or staining are observed. Some sample locations located on the floodplain slope may be inaccessible with a direct-push rig due to the steepness of the slope. At these locations soil samples will be collected from the lithographic zones using a stainless-steel, hollow-core barrel, hand auger sampler

See Table 6-7 for specific sampling and labeling requirements for Phase II direct-push soil sampling activities.

- **Direct-Push Groundwater** – Following the collection of the soil samples, sixteen (16) direct-push borings (DP-25 through DP-40) will be advanced to the water table. The groundwater samples will be collected at the proposed locations along the sampling transect lines from the floodplain slope, at the toe of the floodplain, and on the Kansas River floodplain (see CFI RI/FS Figure 6-5). Groundwater sampling using direct-push technology will be performed in accordance to the SOP #209 in the SAP-IW and SS-SAP. A single groundwater sample will be collected from each of these selected direct-push borings. Groundwater samples collected for TAL metals will be filtered in the field (using a 500 ml Nalgene® disposable filter with 0.45 micrometer [µm] pore size) prior to shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

  See CFI RI/FS WP Table 6-7 for specific sampling and labeling requirements for Phase II direct-push groundwater sampling activities.

- **Installation of Monitoring Wells** – The need for and the number and location of monitoring wells will be determined by the BMcD Project Manager and USACE-CENWK Project Manager following the data evaluation of sampling results from the Phase I and Phase II field activities. If needed, monitoring wells will be installed, within the same water bearing strata, at the CFI Site using hollow stem augers. All monitoring wells will be installed and developed in accordance with SOP #506 included in SOP Series 500 in the SAP-IW Appendix B and the USACE *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Sites*, EM1110-1-4000 (USACE, 1998).

- **Monitoring Well Groundwater Sampling** – If monitoring wells are installed, four (4) monitoring well groundwater sampling events will be conducted including one baseline sampling

event and three quarterly sampling events. Water levels and total depths will be collected at all monitoring wells during all four rounds of monitoring well groundwater sampling. Water levels and total depths will be collected in accordance with SOP #201 included in SOP Series 200 in the SAP-IW Appendix B. These monitoring wells will be sampled using low-flow purging and sampling protocol. Low-flow sampling will be performed in accordance with SOP #205 included in SOP Series 200 in the SAP-IW Appendix B based on the revised SOP for groundwater low-flow purging (USACE-CENWK, 2002). See CFI RI/FS WP Table 6-8 for sampling and labeling requirements for monitoring well groundwater sampling activities.

- **Aquifer Characterization** – If monitoring wells are installed, pneumatic slug testing will be performed on all monitoring wells installed at the CFI Site to better define the hydrogeologic properties of the aquifer. Data collected from the pneumatic slug tests will be uploaded into a hydrogeologic software program to determine the hydraulic conductivity, transmissivity, and storativity of the aquifer. Pneumatic slug testing will be performed in conjunction with the baseline monitoring well groundwater sampling event. Slug testing will be performed in accordance to the SOP #509 included in SOP Series 500 in the SAP-IW Appendix B.

ANALYSIS TASKS:

Soil, stream sediment, surface water, and/or groundwater samples will be analyzed off-site by TestAmerica and/or BRL, as described in SS-SAP Worksheet #11. Detailed descriptions of analysis tasks are included in CFI RI/FS WP Section 6.0. Based on the results from previous site investigations, as described in CFI RI/FS WP Section 6.0, the following analysis tasks will be performed for each sampling task noted above:

Phase I Sampling Activities

- **Background Soil** – Background soil samples will be sent for off-site analysis of TAL metals and SVOCs.

- **Surface Soil and Stream Sediment** – Surface soil and stream sediment samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans.

- **Surface Water** – Surface water samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. Surface water samples collected for TAL metals will be filtered in the field prior to shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

- **Direct-Push Soil** – Direct-push soil samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans.

- **Direct-Push Groundwater** – Direct-push groundwater samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. Groundwater samples collected for TAL metals will be filtered in the field prior to shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

Phase II Sampling Activities

- **Surface Soil and Stream Sediment** – Surface soil and stream sediment samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. However, it is possilbe that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation.

- **Surface Water** – Surface water samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. However, it is possilbe that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation. Surface water samples collected for TAL metals will be filtered in the field prior to shipment. Surface water samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

- **Direct-Push Soil** – Direct-push soil samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. However, it is possilbe that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation.

- **Direct-Push Groundwater** – Direct-push groundwater samples will be sent for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg, SVOCs, and dioxins/furans. However, it is possilbe that some of these analytes will be dropped from the analytical suite as a result of the Phase I data evaluation. Groundwater samples collected for TAL metals will be filtered in the field prior to shipment. Groundwater samples collected for dioxins/furans will be filtered by TestAmerica at the laboratory prior to analysis.

- **Monitoring Well Groundwater Sampling** – Groundwater samples will be collected from each monitoring well for off-site analysis of BTEX, TPH-GRO, TPH-DRO, TAL metals, MeHg,

SVOCs, and dioxins/furans. However, it is possilbe that some of these analytes will be dropped from the analytical suite as a result of the Phase I and Phase II data evaluations. Water quality field parameters of temperature, pH, specific conductivity, DO, and ORP will be measured and recorded in the field during all monitoring well groundwater sampling events. Additionally, during the baseline sampling event, groundwater samples will also be collected for the evaluation of water quality laboratory parameters (alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and TOC) which will be used for natural attenuation monitoring.

The analytical methods for the aforementioned analyses are presented on Worksheets #19 and #20 of the SAP-IW and/or SS-SAP.

QUALITY CONTROL TASKS:

QC samples will be collected and analyzed as described in SS-SAP Worksheet #20. See also SAP-IW Worksheet #28 which details relevant lab and field QC samples.

SECONDARY DATA:

CFI RI/FS WP Section 6.0 discusses a detailed review of the previous investigations performed at the CFI Site.

OTHER DATA:

Data accumulated from the pneumatic slug testing will be handled as noted in SOP #509 included in SOP Series 500 in SAP-IW Appendix B.

DATA MANAGEMENT TASKS:

These tasks are presented in SAP-IW Worksheet #14.

DOCUMENTATION AND RECORDS:

Data package deliverable requirements for TestAmerica and BRL are outlined in SAP-IW Worksheet #29. Field operation documentation and records requirements are outlined in SOP Series 700 in SAP-IW Appendix B. Also included in these SOP(s) is/are examples of the typical field forms that will be used in the documentation.

Project reporting requirements for the CFI Site are shown on CFI RI/FS WP Figure 7-1, including:

- DQCRs
- Monthly Progress Reports
- QCSRs

- Preliminary Exposure Pathway Analysis Report
- Pathway Analysis Report
- RI Report
- BLRA Report

ASSESSMENT / AUDIT TASKS:

These tasks are described in SAP-IW Worksheets #31 and #32.

DATA REVIEW TASKS:

These tasks are described in SAP-IW Worksheets #34, #35, #36, and #37.

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QAPP Worksheet #15
(UFP-QAPP Manual Section 2.8.1)
Reference Limits and Evaluation Table

Analyte	CAS Number	Project Action Limit	Project Action Limit Reference	Project Quantitation Limit Goal	BRL Achievable Laboratory Limits	
					PQLs/LOQ	MDLs/LOD
Worksheet #15 in the SAP-IW provides the above information (where applicable) for the soil, stream sediment, surface water and/or groundwater analyses to be performed by TestAmerica for the CFI RI/FS. This includes BTEX, TPH-GRO, TPH-DRO, TAL metals, SVOCs, dioxins/furans, and/or water quality laboratory parameters. See below for an evaluation of the laboratory reporting limits for soil, steam sediment, surface water, and/or groundwater samples to be analyzed for MeHg by BRL.						
Matrix: Surface Water and/or Groundwater Concentration Level: Low						
Methyl mercury (MeHg)	22967-92-6	1.6 ug/L	RSL (Tapwater)	0.53 ug/L	0.050×10^{-3} ug/L	0.020×10^{-3} ug/L
Matrix: Soil and/or Stream Sediment Concentration Level: Low						
Methyl mercury (MeHg)	22967-92-6	7.8 mg/kg	RSL (Residential Soil)	2.6 mg/kg	0.025×10^{-3} mg/kg	0.008×10^{-3} mg/kg

Notes:
LOD = Limit of Detection
LOQ = Limit of Quantitation
MDL = Method Detection Limit
mg/kg = milligrams per kilogram
PQL = Practical Quantitation Limit
RSL = Regional Screening Level (USEPA, 2012)
ug/L = micrograms per liter

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QAPP Worksheet #16
(UFP-QAPP Manual Section 2.8.2)
Project Schedule / Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
A project schedule/timeline table is provided in CFI RI/FS WP Figure 7-1. The schedule will be routinely updated by BMcD and LBG during the course of the project. A more detailed project schedule is maintained by the USACE-CENWK, LBG, Fort Riley PWE, and BMcD Project Managers.					

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QAPP Worksheet #17
(UFP-QAPP Manual Section 3.1.1)
Sampling Design and Rationale

Describe and provide rationale for choosing the sampling approach:

The overall rationale for the RI/FS is presented in CFI RI/FS WP Sections 4.0 and 6.0. The following data gaps that exist at the CFI Site drive the sampling rationale:

- COPC concentrations for the following sample types/matrices:
    - Background soil samples from an off-site location with an analogous soil type and depositional environment;
    - Surface and subsurface soil samples from overland flow drainage areas to define the horizontal and vertical extent of soil contamination;
    - Stream sediment samples from Threemile Creek;
    - Surface water samples from Threemile Creek;
    - Direct-push groundwater samples to define the horizontal and vertical extent of groundwater contamination, if present;
- Installation and development of monitoring wells screened within the alluvial aquifer;
- COPC concentrations for quarterly groundwater samples collected from newly installed monitoring wells; and
- Hydrogeologic properties of the aquifer.

SS-SAP Worksheet #14 summarizes the sampling and analysis tasks that will be conducted to fill these data gaps. A detailed description of these tasks is provided in CFI RI/FS WP Section 6.0.

Describe the sampling design rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations, the number of samples to be taken, and the sampling frequency:

See SS-SAP Worksheet #18 for sampling methods and requirements and refer to CFI RI/FS WP Section 6.0 (including Figures 6-1 through 6-5 and Tables 6-1 through 6-8) for sample locations and analyses. All concentrations will be reported at a low concentration level (See SAP-IW Worksheet #15). SAP-IW Worksheet #17 and SS-SAP Worksheet #20 discuss the QA/QC activities.

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QAPP Worksheet #18
(UFP-QAPP Manual Section 3.1.1)
Sampling Locations and Methods/SOP Requirements Table

Sampling Location	Matrix	Sample Depth	Analytical Group	Concentration Level	Number of Samples[1] (identify field duplicates)	Sampling SOP Reference[2]	Rationale for Sampling Location
Phase I Sampling Activities							
See CFI RI/FS WP Figure 6-1	Background Soil	See CFI RI/FS WP Section 6.0	TAL Metals[3] SVOCs	Low-level	See CFI RI/FS WP Table 6-1	SOP #103	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-2	Surface Soil	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-2	SOP #102	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-2	Stream Sediment	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-2	SOP #101	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-2	Surface Water	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans[4]	Low-level	See CFI RI/FS WP Table 6-3	SOP #208	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-3	Direct-Push Soil	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-4	SOP #103	See CFI RI/FS WP Section 6.0

Sampling Location	Matrix	Sample Depth	Analytical Group	Concentration Level	Number of Samples[1] (identify field duplicates)	Sampling SOP Reference[2]	Rationale for Sampling Location
See CFI RI/FS WP Figure 6-3	Direct-Push Groundwater	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans[4]	Low-level	See CFI RI/FS WP Table 6-4	SOP #209	See CFI RI/FS WP Section 6.0
Phase II Sampling Activities[5]							
See CFI RI/FS WP Figure 6-4	Surface Soil	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-5	SOP #102	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-4	Stream Sediment	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-5	SOP #101	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-4	Surface Water	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans[4]	Low-level	See CFI RI/FS WP Table 6-6	SOP #208	See CFI RI/FS WP Section 6.0
See CFI RI/FS WP Figure 6-5	Direct-Push Soil	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans	Low-level	See CFI RI/FS WP Table 6-7	SOP #103	See CFI RI/FS WP Section 6.0

Sampling Location	Matrix	Sample Depth	Analytical Group	Concentration Level	Number of Samples[1] (identify field duplicates)	Sampling SOP Reference[2]	Rationale for Sampling Location
See CFI RI/FS WP Figure 6-5	Direct-Push Groundwater	See CFI RI/FS WP Section 6.0	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans[4]	Low-level	See CFI RI/FS WP Table 6-7	SOP #209	See CFI RI/FS WP Section 6.0
The need for and the number and location of monitoring wells will be determined by the BMcD Project Manager and USACE-CENWK PM following the data evaluation of sampling results from the Phase I and Phase II field activities.	Monitoring Well Groundwater	NA	BTEX TPH-GRO TPH-DRO TAL Metals[3] MeHg SVOCs Dioxins/Furans[4] Water quality laboratory parameters[6]	Low-level	See CFI RI/FS WP Table 6-8	SOP #205	See CFI RI/FS WP Section 6.0

[1]Number of samples will be determined based on the finding of the field investigation and/or field screening.

[2]SOPs for sampling and other field activities are included in SAP-IW Appendix B. A detailed SOP reference table is included on SAP-IW Worksheet #21.

[3]TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Surface water and groundwater samples for TAL metals will be filtered in field prior to shipment.

[4]Surface water and groundwater samples for dioxins/furans will be filtered in the laboratory by TestAmerica prior to analysis.

[5]Phase II sampling activities may be revised based upon the Phase I data evaluation. It is likely that some of the analytes will be dropped from the analytical suite as a result of the Phase I data evaluation.

[6]Water quality laboratory parameters include alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and TOC. (Baseline monitoring event only)

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QAPP Worksheet #19
(UFP-QAPP Manual Section 3.1.1)
Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers (Number, Size, and Type)	Sample Volume	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)
The analytical SOP requirements for the MeHg analysis to be performed by BRL are provided below. TestAmerica analytical SOP requirements including sample containers, preservation, and holding times for samples and matrices included in the CFI RI/FS are provided on SAP-IW Worksheet #19. Although TestAmerica analytical SOPs were included in Appendix A of the IW-SAP, all current analytical SOPs are included in Appendix A of this SS-SAP due to revisions.						
Soil / Sediment	MeHg	EPA Method 1630, Modified / BR-0011	4-oz. glass or plastic wide mouth jars	20 g	0-4 °C during shipment; ≤ -15 °C in lab	1 year
Surface Water / Groundwater	MeHg	EPA Method 1630 / BR-0011	Fluoropolymer or glass bottle w/ fluoropolymer-lined lids	250 mL	0-4 °C and dark immediately; HCl to 0.4% in lab within 48 hrs of collection	6 months

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QAPP Worksheet #20
(UFP-QAPP Manual Section 3.1.1)
Field Quality Control Sample Summary Table

The following table summarizes by matrix, analytical group, and concentration level the number of field QC samples that will be collected and submitted to the laboratory.

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD Samples/ Lab Duplicates	No. of Trip Blanks	No. of Rinsate Blanks[2]	No. of PE Samples	Total No. of Samples to Lab
Background Soil	TAL Metals[3] SVOCs	Low-Level	SW-846 3050A / 6010B / 7471A (WS-IP-0002 / WS-MT-0003 / WS-MT-0007) SW-846 3550B / 8270C (WS-OP-0001 / WS-MS-0005)	See CFI RI/FS WP Section 6.0	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	NA	See CFI RI/FS WP Section 6.0

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD Samples/ Lab Duplicates	No. of Trip Blanks	No. of Rinsate Blanks[2]	No. of PE Samples	Total No. of Samples to Lab
Soil (Surface and Direct-Push) and/or Stream Sediment	BTEX	Low-Level	SW-846 5030B or 5035A / 8260B (WS-MS-0007)	See CFI RI/FS WP Section 6.0	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	NA	See CFI RI/FS WP Section 6.0
	TPH-GRO		SW-846 5035 / 8260B (WS-MS-0007)							
	TPH-DRO		SW-846 3550B / 8015B (WS-OP-0004 / WS-GC-0007)							
	TAL Metals[3]		SW-846 3050B / 6010B / 7471A (WS-IP-0002 / WS-MT-0003 / WS-MT-0007)							
	MeHg		EPA Method 1630, Modified (BR-0011)							
	SVOCs		SW-846 3550B / 8270C (WS-OP-0001 / WS-MS-0005)							
	Dioxins/Furans		SW-846 8290 (WS-IDP-0005 / WS-ID-0005)							

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD Samples/ Lab Duplicates	No. of Trip Blanks	No. of Rinsate Blanks[2]	No. of PE Samples	Total No. of Samples to Lab
Water (Surface Water and Direct-Push Groundwater)	BTEX	Low-Level	SW-846 5030B / 8260B (WS-MS-0007)	See CFI RI/FS WP Section 6.0	1 per 10 samples	1 per 20 samples	1 per cooler for aqueous BTEX and TPH-GRO	1 per 20 samples	NA	See CFI RI/FS WP Section 6.0
	TPH-GRO		SW-846 5030B / 8260B (WS-MS-0007)							
	TPH-DRO		SW-846 3510C / 8015B (WS-OP-0004 / WS-GC-0007)							
	TAL Metals[3]		SW-846 3005A / 6010B / 7470A (WS-IP-0001 / WS-MT-0003 / WS-MT-0005)							
	MeHg		EPA Method 1630 (BR-0011)							
	SVOCs		SW-846 3510C / 8270C (WS-OP-0001 / WS-MS-0005)							
	Dioxins/Furans[4]		SW-846 8290 (WS-IDP-0005 / WS-ID-0005)							

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD Samples/ Lab Duplicates	No. of Trip Blanks	No. of Rinsate Blanks[2]	No. of PE Samples	Total No. of Samples to Lab
Water (Surface Water and Direct-Push Groundwater)	BTEX	Low-Level	SW-846 5030B / 8260B (WS-MS-0007)	See CFI RI/FS WP Section 6.0	1 per 10 samples	1 per 20 samples	1 per cooler for aqueous BTEX and TPH-GRO	1 per 20 samples	NA	See CFI RI/FS WP Section 6.0
	TPH-GRO		SW-846 5030B / 8260B (WS-MS-0007)							
	TPH-DRO		SW-846 3510C / 8015B (WS-OP-0004 / WS-GC-0007)							
	TAL Metals[3]		SW-846 3005A / 6010B / 7470A (WS-IP-0001 / WS-MT-0003 / WS-MT-0005)							
	MeHg		EPA Method 1630 (BR-0011)							
	SVOCs		SW-846 3510C / 8270C (WS-OP-0001 / WS-MS-0005)							
	Dioxins/Furans[4]		SW-846 8290 (WS-IDP-0005 / WS-ID-0005)							

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD Samples/ Lab Duplicates	No. of Trip Blanks	No. of Rinsate Blanks[2]	No. of PE Samples	Total No. of Samples to Lab
Monitoring Well Groundwater	BTEX	Low-Level	SW-846 5030B / 8260B (WS-MS-0007)	See CFI RI/FS WP Section 6.0	1 per 10 samples	1 per 20 samples	1 per cooler for aqueous BTEX and TPH-GRO	1 per 20 samples	NA	See CFI RI/FS WP Section 6.0
	TPH-GRO		SW-846 5030B / 8260B (WS-MS-0007)							
	TPH-DRO		SW-846 3510C / 8015B (WS-OP-0004 / WS-GC-0007)							
	TAL Metals[3]		SW-846 3005A / 6010B / 7470A (WS-IP-0001 / WS-MT-0003 / WS-MT-0005)							
	MeHg		EPA Method 1630 (BR-0011)							
	SVOCs		SW-846 3510C / 8270C (WS-OP-0001 / WS-MS-0005)							
	Dioxins/Furans[4]		SW-846 8290 (WS-IDP-0005 / WS-ID-0005)							
	Alkalinity[5]		SM 2320B (WS-WC-0028)							
	Anions[5]		EPA 300.0 (WS-WC-0009)							
	Sulfide[5]		SW-846 9030B / 9034 (DV-WC-0042)							
	TOC[5]		SW-846 9060 (DV-WC-0006)							

[1]Note that TestAmerica and BRL SOPs are considered proprietary information. Copies are included in SAP-IW Appendix A and/or SS-SAP Appendix A.

[2]Rinsate blanks will be collected when non-dedicated field equipment is used. Typically, rinsate blanks are collected at a frequency of 5 percent. Rinsate blanks will be collected at least once a week but no more than once per day.

[3]TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Surface water and groundwater samples for TAL metals will be filtered in field prior to shipment.

[4]Surface water and groundwater samples for dioxins/furans will be filtered in the laboratory by TestAmerica prior to analysis.

[5]Water quality laboratory parameters include alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and TOC. Anions include chloride, nitrate, nitrite, and sulfate.

Note:
MS/MSD = Matrix spike/matrix spike duplicate
PE = Performance Evaluation

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QAPP Worksheet #21
(UFP-QAPP Manual Section 3.1.2)
Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
Project sampling SOP references are provided on SAP-IW Worksheet #21. SOPs required for sampling activities are described on SS-SAP Worksheets #14 and #18.					

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QAPP Worksheet #22
(UFP-QAPP Manual Section 3.1.2.4)
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Field equipment calibration, maintenance, testing, and inspection information is provided on SAP-IW Worksheet #22.									

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QAPP Worksheet #23
(UFP-QAPP Manual Section 3.2.1)
Analytical SOP References Table

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
Analytical SOP references are provided below. TestAmerica and BRL consider their SOPs proprietary information. Although TestAmerica analytical SOPs were included in Appendix A of the IW-SAP, all current analytical SOPs are included in Appendix A of this SS-SAP due to revisions. All TestAmerica and BRL analytical SOPs relevant for the CFI RI/FS sampling activities are included in SS-SAP Appendix A.						
BR-0011	Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Aqueous Samples) and EPA Method 1630, Modified (Solid Samples)	Definitive	MeHg	Cold Vapor Atomic Fluorescence Spectrophotometer (CVAFS)	BRL	N
WS-MS-0007	Determination of Volatile Organics and Total Purgeable Petroleum Hydrocarbons by GC/MS (Revision 4.4, Effective 2/29/2012)	Definitive	VOC and TPH-GRO	Gas Chromatograph/ Mass Spectrometer (GC/MS)	TestAmerica West Sacramento	N
WS-MS-0005	GC/MS Analysis Based on Method 8270C (Revision 4.3, Effective 8/9/2010)	Definitive	SVOC	GC/MS	TestAmerica West Sacramento	N
WS-OP-0001	Extraction of Semivolatile Organic Compounds for Analysis by Method 8270C, Based on SW-846 3500 Series and 3600 Series, and PAH-SIM by Internal Standard and Isotope Dilution Procedures (Revision 3.6, Effective 4/20/2012)	Not Applicable	SVOC - prep	Not Applicable	TestAmerica West Sacramento	N

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WS-ID-0005	Analysis of Samples for Polychlorinated Dioxins and Furans by HRGC/HRMS (Revision 7.5, Effective 4/19/2013)	Definitive	Dioxins/Furans	Gas Chromatograph/ High Resolution Mass Spectrometer (GC/HRMS)	TestAmerica West Sacramento	N
WS-IDP-0005	Preparation of Samples for Analysis of Polychlorinated Dioxins and Furans for Analysis HRGC/HRMS (Revision 1.5, Effective 12/21/2012)	Not Applicable	Dioxins/Furans - prep	Not Applicable	TestAmerica West Sacramento	N
WS-GC-0007	Gas Chromatographic Analysis of Total Petroleum Hydrocarbons (Revision 5.5, Effective 9/14/2012)	Definitive	TPH-DRO	Gas Chromatograph - Flame Ionization Detector (GC-FID)	TestAmerica West Sacramento	N
WS-OP-0004	Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 3500 Series and 3600 Series Methods for Analysis by Methods 8015B, CA-LUFT, NW-TPH, and AK 102/103 (Revision 4.3, Effective 12/14/2012)	Not Applicable	TPH-DRO - prep	Not Applicable	TestAmerica West Sacramento	N
WS-MT-0003	Inductively Couple Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analyses, SW-846 Method 6010B (Revision 5.3, Effective 11/18/2011)	Definitive	Metals	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP)	TestAmerica West Sacramento	N

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WS-IP-0001	Acid Digestion Of Aqueous Samples by SW846 (Methods 3005A, 3010A) (Revision 5.2, Effective 10/31/2012)	Not Applicable	Metals – prep (aqueous)	Not Applicable	TestAmerica West Sacramento	N
WS-IP-0002	Acid Digestion of Soils, SW-846 Method 3050B (Revision 5.3, Effective 1/19/2012)	Not Applicable	Metals – prep (solid)	Not Applicable	TestAmerica West Sacramento	N
WS-MT-0005	Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1 (Revision 5.4, Effective 6/22/2012)	Definitive	Mercury (aqueous)	Cold Vapor Atomic Absorption (CVAA)	TestAmerica West Sacramento	N
WS-MT-0007	Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption (Revision 5.2, Effective 1/20/2012)	Definitive	Mercury (solid)	CVAA	TestAmerica West Sacramento	N
WS-WC-0009	Determination of Anions by Ion Chromatography (EPA Method 300.0 - Part A, SW-846/Method 9056) (Revision 3, Effective 4/13/2012)	Definitive	Anions	Ion Chromatograph (IC)	TestAmerica West Sacramento	N

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WS-WC-0028	Determination of Alkalinity, Conductivity, and pH (Methods SM 4500 H+ -B, SM 2320B, EPA 9040B, EPA 9040C w/ Update IV, EPA 120.1) (Revision 4.3, Effective 7/20/2012)	Definitive	Alkalinity	Autotitrator	TestAmerica West Sacramento	N
DV-WC-0042	Total Sulfide Sample Preparation and Titration (SW 9030B/SW9034) (Revision 3.3, Effective 6/29/2012)	Definitive	Sulfide	Not Applicable	TestAmerica Denver	N
DV-WC-0006	Carbon in Water (TOC, TIC, DOC, and TC) (Revision 9, Effective 2/7/2013)	Definitive	TOC	Carbonaceous Analyzer	TestAmerica Denver	N

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QAPP Worksheet #24
(UFP-QAPP Manual Section 3.2.2)
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Analytical instrument calibration information is provided on SAP-IW Worksheet #24 for analyses to be performed by TestAmerica. Instrument calibration information for MeHg analysis by BRL is provided in SOP #BR-0011 included in SS-SAP Appendix A.						

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QAPP Worksheet #25
(UFP-QAPP Manual Section 3.2.3)
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
TestAmerica analytical instrument and equipment maintenance, testing, and inspection information is provided on SAP-IW Worksheet #25. BRL analytical instrument and equipment maintenance, testing, and inspection information is provided in their QAM included in SS-SAP Appendix A.								

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QAPP Worksheet #26
(UFP-QAPP Manual Appendix A)
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
SAMPLE RECEIPT AND ANALYSIS
SAMPLE ARCHIVING
SAMPLE DISPOSAL
Sample handling information is provided on SAP-IW Worksheet #26.

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QAPP Worksheet #27
(UFP-QAPP Manual Section 3.3.3)
Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to the laboratory):
See below.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
See below.

Sample Identification Procedures:
See below.

Chain-of-Custody Procedures:
See below.

Sample custody requirements are provided on SAP-IW Worksheet #27 and in SOP Series 700 in SAP-IW Appendix B.

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QAPP Worksheet #28
(UFP-QAPP Manual Section 3.4)
QC Samples Table

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
QC sample information is provided on SAP-IW Worksheet #28 for the soil, stream sediment, surface water and/or groundwater samples planned for collection at the CFI Site. Planned sample frequency and locations for field duplicate samples, rinsate samples, and MS/MSD samples are provided on Tables 6-1 through 6-8 of the CFI RI/FS WP. Analyses for these sample matrices include one or more of the following: BTEX, TPH-GRO, TPH-DRO, TAL metals, SVOCs, dioxins/furans, MeHg, and/or water quality laboratory parameters.						

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QAPP Worksheet #29
(UFP-QAPP Manual Section 3.5.1)
Project Documents and Records Table

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records	Other
Project documents and records information is provided on SAP-IW Worksheet #29. This SAP-IW Worksheet also provides a detailed discussion of project documents including data package deliverables, data reporting formats, data handling and management, and data tracking and control.				

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QAPP Worksheet #30
(UFP-QAPP Manual Section 3.5.2.3)
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Number	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)
Analytical services information for analyses to be performed by TestAmerica is provided on SAP-IW Worksheet #30. See below for analytical services information for BRL.						
Soil / Sediment / Surface Water / Groundwater	MeHg	Low	See CFI RI/FS WP Section 6.0	BR-0011	30 days	Brooks Rand Labs, LLC 3958 6th Ave NW Seattle, WA 98107 Project Manager: TBD

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QAPP Worksheet #31
(UFP-QAPP Manual Section 4.1.1)
Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Planned project assessment information is provided on SAP-IW Worksheet #31.							

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QAPP Worksheet #32
(UFP-QAPP Manual Section 4.1.2)
Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Assessment findings and corrective action response information is provided on SAP-IW Worksheet #32.						

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QAPP Worksheet #33
(UFP QAPP Manual Section 4.2)
QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
QA management reports information is provided on SAP-IW Worksheet #33.				

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QAPP Worksheet #34
(UFP-QAPP Manual Section 5.2.1)
Verification (Step I) Process Table

This worksheet and text describes the processes that will be followed to verify project data. *Internal* or *external* is in relation to the data generator.

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Step I verification process information is provided on SAP-IW Worksheet #34.			

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QAPP Worksheet #35
(UFP-QAPP Manual Section 5.2.2)
Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
Validation process information is provided on SAP-IW Worksheet #35.			

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QAPP Worksheet #36
(UFP-QAPP Manual Section 5.2.2)
Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
Validation summary information is provided on SAP-IW Worksheet #36. This includes Steps IIa and IIb validation activities.					

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QAPP Worksheet #37
(UFP-QAPP Manual Section 5.2.3)
Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps any statistics, equations, and computer algorithms that will be used:

See below.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

See below.

Identify the personnel responsible for performing the usability assessment:

See below.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

See below.

Information regarding usability assessment is provided on SAP-IW Worksheet #37.

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Burns and McDonnell (BMcD), 2003, *Installation-Wide Investigative-Derived Waste Management Plan for Environmental Investigations at Fort Riley, Kansas.*

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USACE-CENWK, 2004, *Draft Final Installation-Wide Sampling and Analysis Plan for Environmental Investigations at Fort Riley, Kansas.*

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TABLES

Table 12-1
QC Sample Acceptance Limits
Methyl Mercury by EPA Method 1630
CFI Site
Fort Riley, Kansas

Matrix: Soil and/or Stream Sediment **Method: EPA Method 1630, Modified**									
Parameter	**CRM**			**MS/MSD**			**Surrogates**		
	REC Acceptable Limits[1]		**RPD Acceptable Limit[1]**	**REC Acceptable Limits[1]**		**RPD Acceptable Limit[1]**	**REC Acceptable Limits[1]**		**RPD Acceptable Limit[1]**
	Lower (%)	**Upper (%)**	**(%)**	**Lower (%)**	**Upper (%)**	**(%)**	**Lower (%)**	**Upper (%)**	**(%)**
Methyl mercury	65	135	NA	35	135	35	50	150	NA

Matrix: Surface Water and/or Groundwater **Method: EPA Method 1630**									
	LCS (BS)			**MS/MSD**			**Surrogates**		
Parameter	**REC Acceptable Limits[1]**		**RPD Acceptable Limit[1]**	**REC Acceptable Limits[1]**		**RPD Acceptable Limit[1]**	**REC Acceptable Limits[1]**		**RPD Acceptable Limit[1]**
	Lower (%)	**Upper (%)**	**(%)**	**Lower (%)**	**Upper (%)**	**(%)**	**Lower (%)**	**Upper (%)**	**(%)**
Methyl mercury	70	130	30	65	135	35	70	130	NA

[1]Recovery and precision limits are current at the time of SOP revision. Recoveries are reviewed and updated annually and are subject to change.

BS = Blank Spike
CRM = Certified Reference Materials
LCS = Laboratory Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
NA = Not applicable
REC = Percent Recovery
RPD = Relative Percent Difference

APPENDIX A

Laboratory Documentation

(provided on CD)

TestAmerica West Sacramento

Quality Assurance Manual

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Approval Signatures:

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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
WS-PQA-013	Procedures to Address Customer Complaints
WS-QA-0050	Management of Change
WS-QA-0009	Document Archiving
WS-QA-0022	Employee Orientation and Training
WS-QA-0021	Preparation and Management of Standard Operating Procedures
WS-QA-0006	Method Detection Limits (MDL) and Instrument Detection Limits (IDL)
WS-PQA-0011	Manual Integration Documentation Procedures
WS-QA-0018	Subsampling and Compositing of Samples
WS-QA-0003	Sample Receipt and Procedures

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica West Sacramento's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *U.S. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Statement of Work for Inorganics & Organics Analysis, SOM, ISM, DLF and CBC, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, and on-line Editions.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 4. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control & Updating procedures (refer to SOP No. WS-QA-0021).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica West Sacramento is a local operating unit of TestAmerica Laboratories, Inc.. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica West Sacramento is presented in Figure 4-1.

Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.1.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's West Sacramento laboratory.

4.1.2 Laboratory Director / Technical Director

TestAmerica West Sacramento's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

4.1.3 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025.

4.1.4 Technical Manager (Operations Manager) or Designee

The Operations Manager has the responsibility for the day to day operations of the analytical staff within the laboratory. **The Operations Manager is responsible for compliance with the ISO 17025 Standard.** The Operations Manager reports directly to the Laboratory Director. The Operations Manager schedules analytical operations, ensures that the laboratory meets quality requirements, investigates technical issues as they arise, and performs other tasks as required by the NELAC standards.

4.1.5 Manager of Customer Services

The Manager of Customer Services has the responsibility for the day to day operations of the client services staff, which includes the Project Management and other administrative groups within the laboratory. The Manager of Customer Services reports directly to the Laboratory Director. The Manager of Customer Services has signature authority for contracts for laboratory services (as detailed in TestAmerica policy), and for laboratory reports.

4.1.6 Project Manager

Project Managers are a liaison between the laboratory's clients and the analytical staff. They report directly to the Manager of Customer Service. The Project Managers have signature authority for final reports, and review project data packages for completeness and compliance with client needs and quality requirements.

4.1.7 Project Administrator

Project Administrators are a liaison between the laboratory's clients and the analytical staff. They report directly to the Manager of Customer Service. The Project Administrators review project data packages for completeness and compliance with client needs and quality requirements.

4.1.8 Department Manager, Team Leader, or Supervisor

Department Managers report directly to the Operations Manager. They supervise the daily activities of analysis with a given laboratory area, and either oversee the review and approval, or perform the review and approval of all analytical data within that area.

4.1.9 Analyst

Analysts report to their respective Department Managers. They perform sample analyses and generate analytical data in accordance with documented procedures.

4.1.10 Sample Custodian

The Sample Custodian ensures the implementation of proper sample receipt procedures, including maintaining chain-of-custody. The Sample Custodian logs samples into the LIMS and ensures that all samples are stored appropriately.

4.1.11 Report Production Staff

The Report Production Staff accurately generates and compiles analytical reports and the associated deliverables as required by the client.

4.1.12 Quality Assurance Staff

The QA Staff has responsibility and authority to ensure the continuous implementation of the quality system based on ISO 17025.

- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying the QA manager of deficiencies in the quality system and ensuring corrective action is taken.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025. (where applicable)

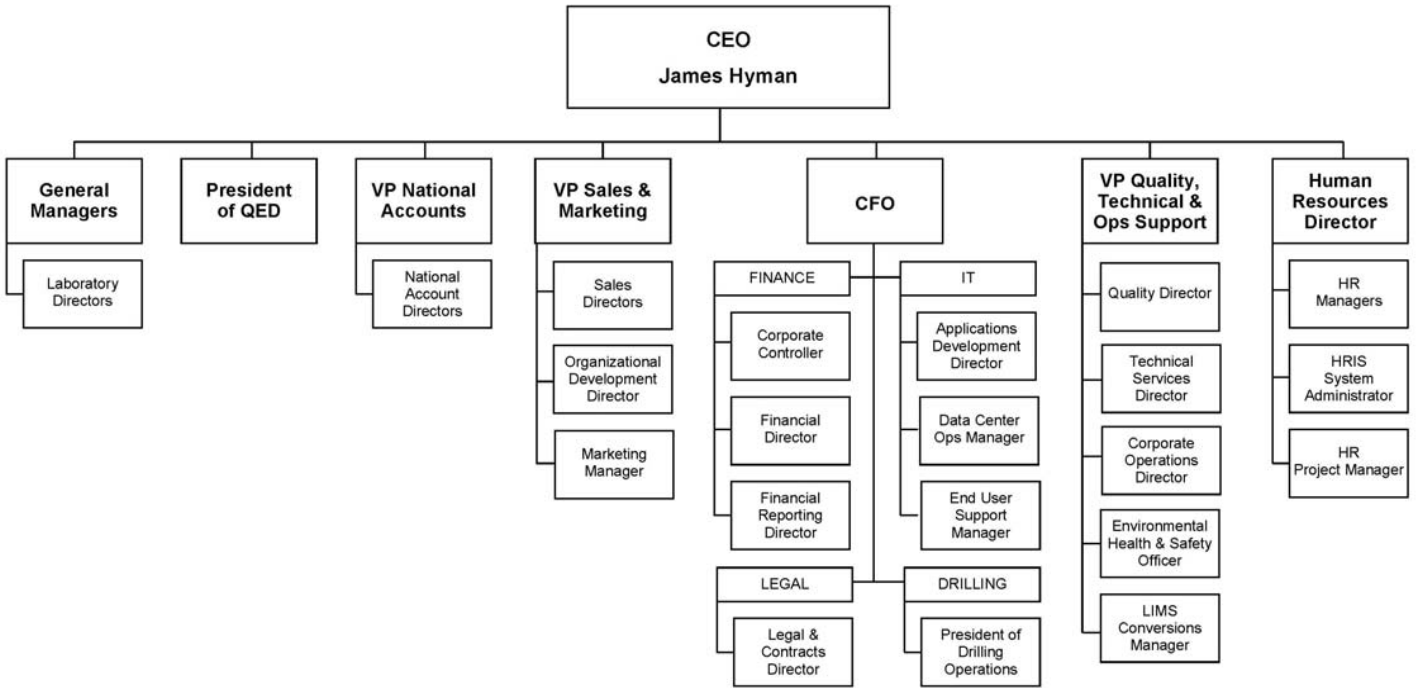
4.2 Deputies

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Karla Buechler Laboratory Director	David J. Herbert Business Development Director
Douglas Weir Quality Manager	Lisa Stafford Quality Assurance Scientist
Karla Buechler Technical Director	Eric Redman Technical Director Robert Hrabak Environmental Operations Manager
Robert Hrabak Environmental Operations Manager	Steve Rogers Department Manager Kirby Garrett Department Manager
David Allameh Adv. Tech. Operations Manager	Robert Hrabak Environmental Operations Manager
David Herbert Business Development Manager	Eric Redman Technical Director
David Herbert Customer Service Manager	Jill Kellmann Program Management Department Manager
Joseph Schairer EHS Coordinator	Richard Kester Hazardous Materials Specialist

Figure 4-1. Corporate and Laboratory Organization Charts

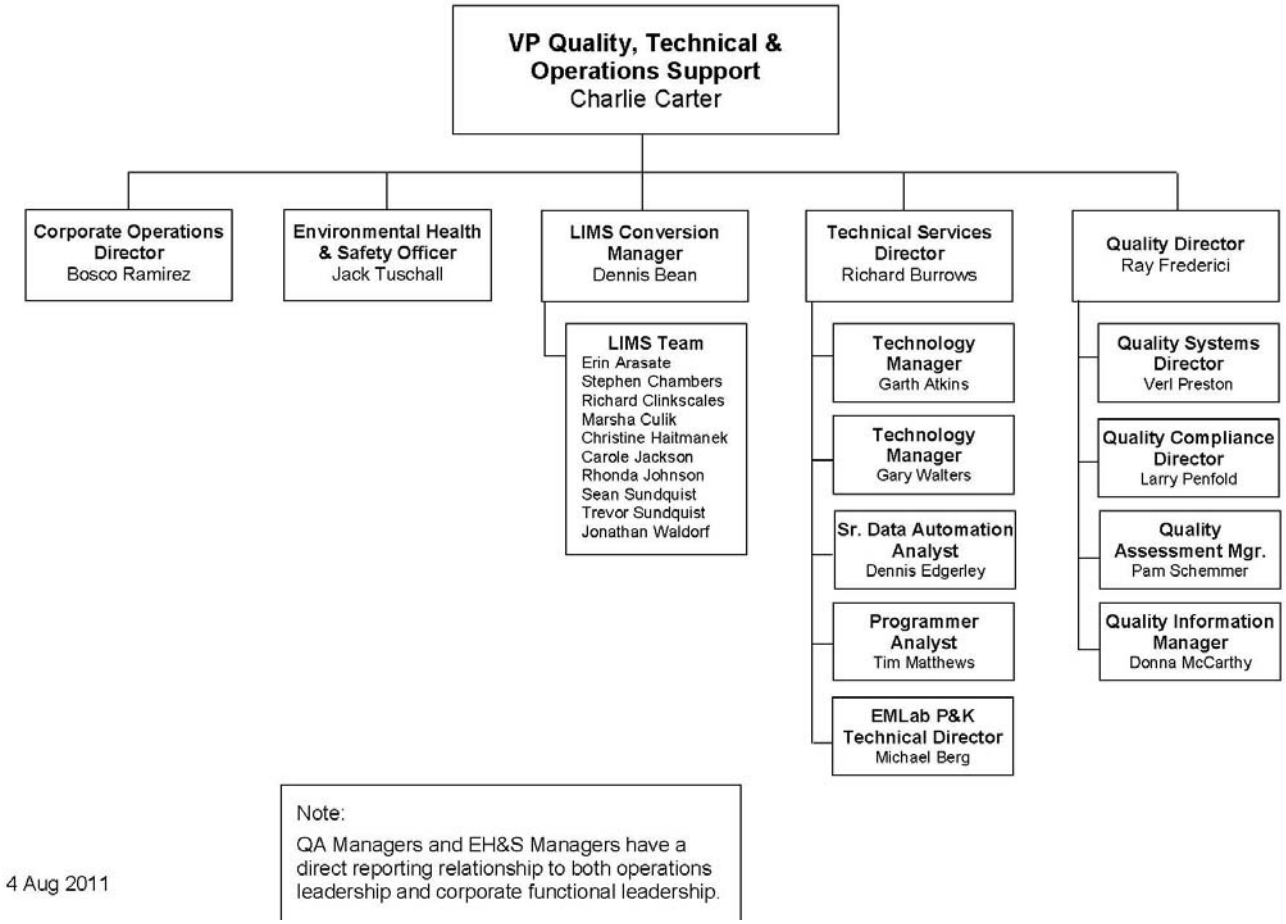
TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING



Aug 2011

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Quality, Technical & Operations Support



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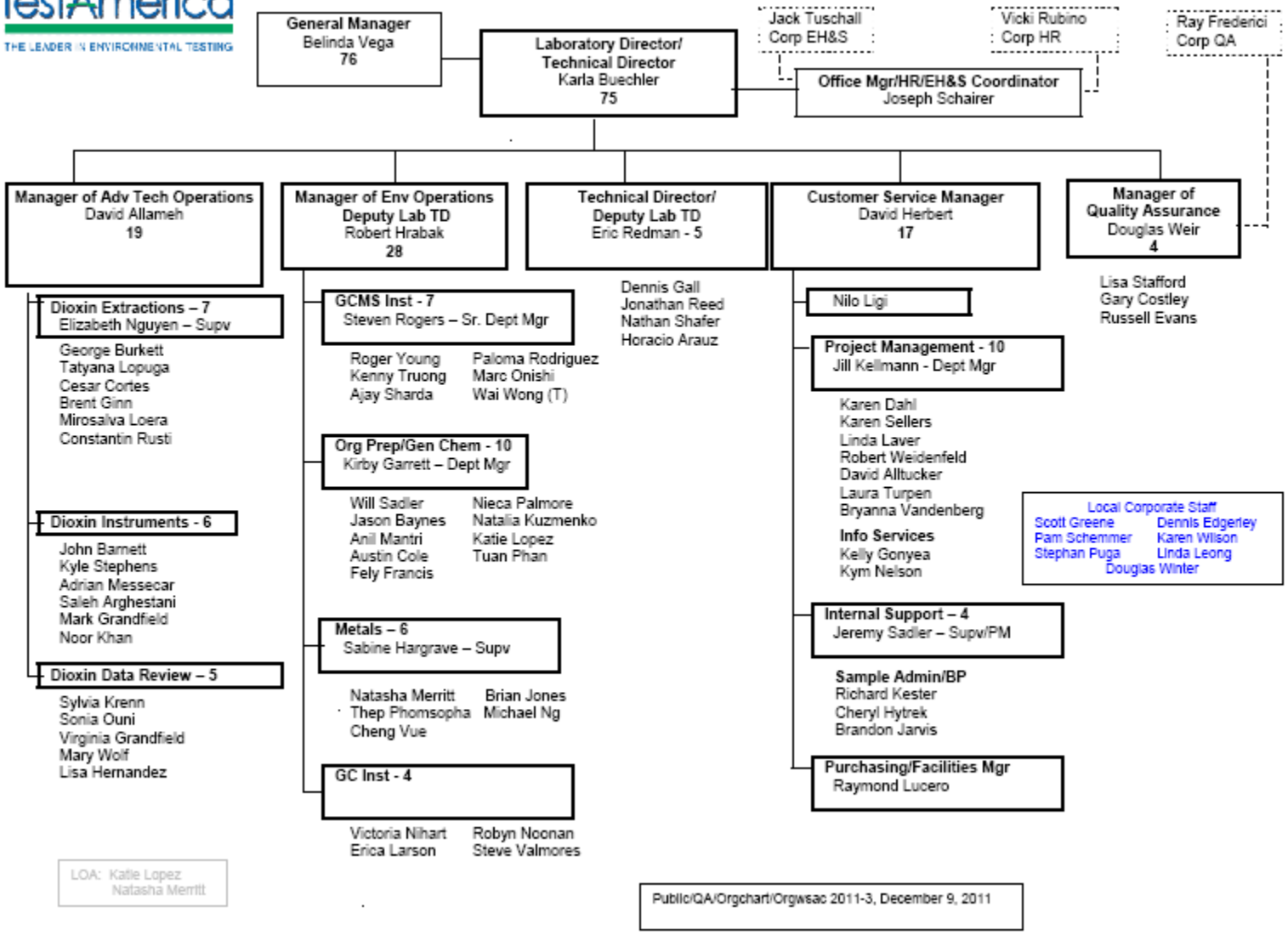
West Sacramento Laboratory Organization



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- ❖ Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- ❖ Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- ❖ Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- ❖ Provide clients with the highest level of professionalism and the best service practices in the industry.
- ❖ To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct (Corporate SOP No. CW-L-S-002).
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.

- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit).

5.5 Criteria for Quality Indicators

The laboratory maintains a Reference Data Summary from the LIMS that summarizes the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits is contained in "Quality Control Pogram" Policy WS-PQA-003 and Section 24.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Technical Manager and QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Quality Control Program" Policy WS-PQA-003 and Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

As the QC limits are calculated, QC charts are generated showing warning and control limits for the purpose of evaluating trends. The QA Manager evaluates these to determine if adjustments need to be made or for corrective actions to methods. All findings are documented and kept on file. Control charts are generated according to laboratory SOP No. WS-PQA-003, "Quality Control Program".

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP No. WS-QA-0021, "Preparation and Management of Standard Operating Procedures".

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department (or list other mgmt. if applicable). In order to develop a new document, a manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their

distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP No. WS-QA-0021, "Preparation and Management of Standard Operating Procedures". Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the QA share on the local server for the applicable revision, and are accessible using the laboratory's Intranet.

For changes to SOPs, refer to SOP No. CW-Q-S-002, Writing a Standard Operating Procedure SOP and SOP No. WS-QA-0021, Preparation and Management of Standard Operating Procedures". The SOPs identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized by department in the QA office. There is a table of contents. Electronic versions are kept on a hard drive in the QA department; hard copies are kept in QA files. The procedure for the care of these documents is in SOP No. WS-QA-0021, "Preparation and Management of Standard Operating Procedures".

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP No. WS-QA-0021, Preparation and Management of Standard Operating Procedures.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. The PM will also get approval by the Laboratory Director to commit to delivery schedules that are shorter than the published standard TATs. The Laboratory Director updates these TATs on a routine basis, and it is the responsibility of CSMs and PMs to review them prior to making commitments for the laboratory.

It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

If the project is an air, drinking water, or high resolution opportunity, a message describing the opportunity will be immediately sent to the appropriate specialty market distribution list.

New opportunities with an estimated value greater than $100K are passed to the laboratory CSM or BDM, and a message regarding the project details is immediately forwarded to the Large Opportunity Tracking (LOT) distribution list. Specialty market distribution will be included in this notification as appropriate, as well as the associated sales person.

The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- The Customer Service Manager
- The Business Development Manager
- Laboratory and/or Corporate Technical Managers / Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Account Executives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The Sales Director, Legal Contracts Director, Account Executive, Proposal Coordinator or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts**,** as does the local Business Development Manager.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Contract negotiations and finalization is the responsibility of the Business Development Manager. These records are archived by client and project in a restricted network folder accessible to laboratory department managers, project managers, and senior managers.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. Each Laboratory Project Manager keeps a phone log of conversations with the client. In addition, all conversations involving notification of important information, or actions directed by the client are documented with a follow up e-mail and archived in the contracts folder or the SDG documentation and case narrative. Instances include change in scope, alterations to the requests listed on a chain of custody, directions to proceed in the event of a non-conformance, and any other conversation that changes the direction of a COC or contract.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements. Quality Assurance Project Plans, if submitted by the client, will be evaluated per policy WS-PQA-0018.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition,

project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are updated to the QAS and introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Any member of the laboratory's senior staff, or any of the laboratory's identified technical experts is available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required.

Project Managers (PMs), Customer Service Managers (CSM), or Account Executives (AE) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g, USDA) or contracts (e.g, certain USACE projects) may require notification prior to placing such work. Documentation of approval is stored electronically in the quote folder within SACSALES share on a local laboratory server.

8.2 Qualifying and Monitoring Subcontracators

Whenever a PM or Customer Service Manager becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site.

Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).

- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, PMS or CSMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.

- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM (or CSM) responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is stored electronically in the quote folder within the SACSALES share on a local laboratory server. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples workshared within TestAmerica. Client CoCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client CoCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples. Results submitted by a network work-sharing laboratory on the same LIMS will be designated in the case narrative.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods

and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.

Example 1 - Subcontracted Sample Form – form

Date/Time: _____

Subcontracted Laboratory Information:

- Subcontractor's Name: _____
- Subcontractor Point of Contact: _____
- Subcontractor's Address: _____
- Subcontractor's Phone: _____
- Analyte/Method: _____
- Certified for State of Origin: _____
- TNI Certified: Yes_____No_____
- **USDA Permit (__Domestic __ Foreign)** **Yes**_____**No**_____
- A2LA (or ISO 17025) Certified: Yes_____No_____
- CLP-like Required: Yes_____No_____
  (Full doc required)
- Requested Sample Due Date: _____
  (Must be put on COC)
- **Client POC Approval on-file to Subcontract Samples to Sub Laboratory:** **Yes**_____**No**_____

Project Manager: _____

Laboratory Sample # Range: _____
(Only of Subcontracted Samples)

Laboratory Project Number (Billing Control #): _____

All subcontracted samples are to be sent via bonded carrier and Priority Overnight. Please attach tracking number below and maintain these records in the project files.

PM Signature_____**Date**_____

Example 1 - Subcontracted Sample Form – Within TestAmerica

TestAmerica	Work Sharing Agreement (Include with every sample shipment)		Exporting Lab	TAL Chicago
			Project Name	
Import Lab Information			Export Lab Information	
Lab Name	TAL Chicago		PM Contact Name	
PM Contact Name			Backup Contact Name	
Backup Contact Name			Agreement Date	
Pricing Information			Project Information	
QA/QC (i.e. MS/MSD) Billable?	No		Client Company Name	
Raw Data Surcharge		%	Date First Samples to Arrive	
EDD Surcharge		%	Est. Duration of Sampling Event	
TAT Surcharges		%		
Penalty Terms	None			
Other Charges Not In Unit Price? (i.e. canisters, Level IV/III , shipping, bottles)	None		Quote or Contract Reference ID	
Project Details				
Non-Standard Work Product	No			
Quality Assurance Plan	No			
List Certifications Required				
Analyte/Cmpd. List with RLs Attached	No			
Results Dry-Weight Corrected	No			
Special Method Holding Times	None			
Internal Chain of Custody Required	No			
Known Hazards/High Analyte Level	No			
Saturday/Special Delivery Options	None			
Special Instructions	None			
Reporting Limit Value Convention	Report to MDL with "J" Values up to	"Non-Detect" Presentation Convention		U

Deliverable Requirements		Transmittal medium	Format Column	Date Due to Export Lab	Import and Export Lab Agreement
Preliminary Report:	No				*Import lab must acknowledge*
Final Report:	No				receipt of Agreement and samples
EDD:	No		Type Format Name		*via E-Mail*
Total Access Reporting	No	NA	NA		
Custom Forms:	No	NA	Type Format Name		
"Other" Deliverable Definitions or Notes					

Analysis	Method	Matrix	# of Samples	Import Lab's Unit Price	Unit Price w/Surcharges	Extended Price
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					Approximate Total Project Value	$ -

Work Instruction No. CA-WI-010/B-10/08

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. Many items used routinely are pre-qualified and placed into the the on-site consignment system.

For items not available from the consignment system, or items that are not used routinely, an order in placed in the JDE ordering system. Only personnel trained in the ordering program JDE may place orders using the program. All relevant information, including quantity, must be entered. Only approved vendors may be used. A vendor must be approved by corporate to be

on the approved vendor list in JDE. The Laboratory Director or designee approves all orders placed in JDE.

9.3.2 Receiving

It is the responsibility of the purchasing manager to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials here received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals unless noted otherwise by the manufacturer or by the reference source method. Chemicals should not be used past the manufacturer's or SOP's expiration date unless 'verified'. See laboratory SOP No. WS-QA-0017, "Standards and Reagent Preparation and Quality Control Check Procedures", for standard verification procedures.)

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning every other day. For single tanks in use at the bench, the minimum total pressure must be 500 psig or the tank must be replaced. To prevent a tank from going to dryness, close observation of the tank gauge must take place as pressure decreases towards 500 psig, or the tank must be replaced. For the automated "tank farm" in use through most of the laboratory, the minimum total pressure at which the system switches to the next bank of tanks is 250 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard. See laboratory SOP No. WS-QA-0017, "Standards and Reagent Preparation and Quality Control Check Procedures", for standard QC procedures.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section. Certificates of analysis are also scanned and stored electronically. These records include date of receipt, lot number (when applicable), and expiration date (when applicable).

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Manager/Director and/or the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench and inventoried in the master document list.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is

determined by analysts and/or Technical Managers. The service providers that perform the services are approved by the Technical Manager.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP No. CW-F-S-018) and Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technology Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following laboratory policy WS-PQA-013, Procedure to Address Customer Complaints.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to laboratory policy WS-PQA-013, Procedure to Address Customer Complaints.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Technical Director or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Director and QA Manager, documented and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, a Technical Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc.. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be

documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the COO, General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

11.4 Prevention of NonConforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule, (or add the lab's schedule; i.e., monthly, weekly) the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical Manager/Director, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCM) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc..

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCMs.
- Issues found while reviewing NCMs that warrant further investigation.
- Internal and external audit findings.
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Client complaints

- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports
- Health and Safety violations

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Laboratory SOP No. WS-QA-0023, Nonconformance and Corrective Action System, provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technical Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the

likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each NCM and CAR is entered into a database for tracking purposes and are periodically reviewed to ensure that the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred

(refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Laboratory SOP No. WS-QA-0023, "Nonconformance and Corrective Action System" includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Laboratory SOP No. WS-QA-0023, "Nonconformance and Corrective Action System" provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The SOP also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original "uncorrected" file must be maintained intact and a second "corrected" file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

West Sacramento
Corrective Action Report

Title: <Enter Title Here>

Reference: <tracking information>

Initiated by: **Date:**

Responsible Party: **Date:** <date report submitted>

Description of Problem:
[enter text to briefly explain how the problem was discovered, who discovered it and when, and what work, if any, is affected]

Investigation Planned or Completed:
[enter text to briefly what was examined to determine the extent of the problem, when the investigation was conducted, what was the proximate cause(s), and what were the root causes. The key is to demonstrate that the investigation is comprehensive]

Root Cause Analysis
[True root cause analysis should involve multiple layers of questioning]
Examples:
- Why did this problem occur?
- What weaknesses are indicated by this problem?
- What Quality Systems mechanisms are in place that should have prevented this problem from occurring?
- Is this issue acute or chronic?
- Are changes needed to existing SOPs to correct this problem and prevent its recurrence?
- Are other departments affected by this issue?

Corrective Action Plan
[Based on the Root Cause Analysis outlined above, what action items need to be completed to correct this deficiency, and prevent its recurrence?]
Examples:
- Identify impacted lots
- Revise results/reports
- Initiate formal Data Recall
- Revise SOP
- Re-train staff

QA Monitoring of Corrective Action Status
[If an anomalous or isolated event, and no further action required, this section may be omitted. Otherwise, note the need for a routine follow-up assessment and the associated details (responsible party, due date, documentation necessary), or the need to add to the internal audit checklist for reassessment at a later date.

Closed by: _____ _____
Douglas Weir QA Manager Date

Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank *(Analyst)*	- Instrument response < MDL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards *(Analyst, Technical Manager(s))*	- Correlation coefficient > 0.99 or standard concentration value. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Technical Manager(s))*	- % Recovery within control limits.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in the LIMS or Project QAPP.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in the LIMS or Project QAPP.	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean.	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1]	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples *(QA Manager, Technical Manager(s))*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Technical Manager(s), Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc..	- Non-conformances must be investigated through CAR system and necessary corrections must be made.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002.
Client Complaints *(Project Managers, Lab Director/Manager, Sales and Marketing)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director/Manager, *Technical Manager(s)*)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director/Manager, *Technical Manager(s)*)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

Note:
1. Except as noted below for certain compounds, the method blank should be below the detection limit. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants as defined in policy WS-PQA-003 **provided** they appear in similar levels in the reagent blank and samples. The ubiquitous contaminants include: methylene chloride, toluene, acetone, 2-butanone, phthalates and octachlorodibenzodioxin. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc..

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc.. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: Facility Changes, Major Accreditation Changes, Addition or Deletion to Division's Capabilities or Instrumentation, Key Personnel Changes, Laboratory Information Management System (LIMS) changes. This process is discussed in further detail in WS-QA-0050, Management of Change Procedures.

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA department in a database or in specific folders on the QA share on the local server, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by Department Managers.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*

	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records (Add Permits?)	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained indefinitely)
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or the Iron Mountain data storage facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log**.** Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Records before 09/09/2009 were maintained on-site at the laboratory for at least 1 month after their generation and moved offsite for the remainder of the required storage time. Records generated after 09/09/2009 are maintained on-site at the laboratory for at least 1 month after their generation and then scanned into PDF files. The electronic files are stored on-site and backed up daily offsite. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 and WS-PQA-017 for more information.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set.) Refer to SOP WS-QA-0009, Document Archiving. Instrument data is stored by project, except for inorganics and calibration data. Inorganics and calibration data is stored sequentially by instrument as appropriate. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP WS-QA-0009.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'**.**

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code**;**
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72)

hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook, on a benchsheet or in the LIMS.

- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- sample preparation including cleanup, separation protocols, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents**;**
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats**.**

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value**;**
- copies of final reports**;**
- archived SOPs**;**
- correspondence relating to laboratory activities for a specific project**;**
- all corrective action reports, audits and audit responses**;**
- proficiency test results and raw data; and

- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in a logbook or using the Veritas Electronic Standards Logbook. Records are considered archived when noted as such in the records management system (a.k.a., document control.)

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in

cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a “Certificate of Destruction” is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Auditing, SOP No. CA-Q-S-004. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CA-Q-S-004)	Methods Audits Frequency: 100% of methods annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner and Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Soil, Water Supply, Water Pollution, Air, and round-robin studies for sediments and biological materials.

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are

responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Technical Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Technical Managers, their Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Managers, QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel is be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that can not be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 & Work Instruction No. CA-Q-WI-020) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.

- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's COO, VP of Client & Technical Services, General Managers and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, Conductivity, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC)	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Technical Managers – **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP (WS-QA-0022, Employee Orientation and Training).

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 66,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory. In the event of a power outage, the laboratory can be equipped with a back up power supply for sample storage, as detailed in SOP No. WS-QA-0005, Temperature Monitoring and Corrective Action for Refrigerators and Freezers.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Employees wear photographic identification name cards while on the premises.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002 or the laboratory's SOP WS-QA-0021 (Preparation and Management of Standard Operating Procedures).
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1996.*
- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Statement of Work for Inorganics & Organics Analysis, SOM, DLM, CBC, and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*

- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*
- *Underground Storage Tanks Procedures Manual, State of Alaska Department of Environmental Conservation, Division of Spill Prevention and Response Contaminated Sites Program, November 7, 2002*
- *Tri-Regional Board Staff Recommendations for Preliminary Investigation and Evaluation of Underground Tank Sites, North Coast Regional Water Quality Control Board, San Francisco Bay Regional Water Quality Control Board and Central Valley Regional Water Quality Control Board, August 10, 1990*
- *Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997*
- *Compendium of Methods for the Determination of Air Pollutants in Indoor Air, (EPA 600/4-90-10, April 1990)*
- *Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air, (EPA 625/R-96/010a, June 1999*
- *Methods for Determining Emissions of Toxic Air Contaminants from Stationary Sources, Stationary Source Test Methods, Volume 3, California Air Resources Board*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC, Lab SOP # WS-QA-0022) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Director and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1 as an example) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

In accordance with Arizona Administrative Code R9-14-616.5f, documentation of each analyst's performance of proficiency testing, as applicable, will be maintained in the training record.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL.

Alternatively, the MDL may be determined using a series (ideally 50-100) of method blanks for “uncensored” methods which always return a signal (i.e., ICP).

Refer to the Corporate SOP No. CA-Q-S-006 or the laboratory’s SOP No. WS-QA-0006 for details on the laboratory’s MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

If IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at no more than 3 times the calculated MDL for single analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and no more than 4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. The analytes must be qualitatively identified or see SOP No. WS-QA-0006 for other options. If the MDL does not verify, then the lab will not report to the MDL, or redevelop their MDL or use the level where qualitative identification is established. MDLs must be verified at least annually.

For DoD ELAP certified methods: Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. Refer to the laboratory SOP WS-QA-0006, Method Detection Limits (MDL) and Instrument Detection Limits (IDL) for further details.

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at 1-2 times the reporting limit and annually thereafter. The annual requirement is waved for methods that have an annually verified MDL. The laboratory will comply with any regulatory requirements.

For DoD ELAP certified methods: The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the

Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent

recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k = 3. As an example, for a reported result of 1.0 mg/L with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 +/- 0.5 mg/L.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.**

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Department Manager *or* Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP Nos. S-ITQ-005, "QuantIMS/JDE user Profile Setup and Maintenance", and S-ITQ-007, "Software Testing, Validation and Verification." The laboratory is currently running QuantIms which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes DB2 which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 **Maintain the Database Integrity:** Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices* and WS-PQA-011, Manual Integration Documentation Procedures.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff.

Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/L, results can be reported in percent, i.e., 10,000 mg/L = 1**%.** Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.

- Worksheets are created with the approval of the Technical Director/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are out lined in several SOPs (WS-PQA-003, "Quality Control Program", WS-PQA-012, "Technical Data Review Requirements", WS-PM-0004, "Final Report Assembly and Third Level Data Review") to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data (WS-PQA-0011, "Manual Integration Documentation and Practices"). The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into a computer LIMS. The Sample Control Supervisor reviews the transaction of the chain-of-custody forms and the inputted information. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. One hundred percent of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Director/Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.4.7 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for our internal SOP No. WS-PQA-0011, entitled "Manual Integration Documentation and Practices.

19.14.4.8 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.4.9 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission

of correct information) is against company principals and policy and is grounds for immediate termination.

19.14.4.10 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.4.11 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Demonstration of Capability Certification Statement

TestAmerica West Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
(916) 373-5600

Date: 28 June 2011
Method: 1613B
Matrix: Aqueous
SOP: WS-ID-0007 rev. 3.6

Analyst(s): M. GRANDFIELD

We, the undersigned, CERTIFY that:

1: The analyst(s) identified above, using the cited test method, with the specifications in the cited SOP, which is in use at the facility for the analysis of samples under the TestAmerica West Sacramento Quality Assurance Manual, has met the Demonstration of Capability.

2: The test method was performed by the analyst(s) identified on this certification following the TestAmerica West Sacramento SOP.

3: A copy of the laboratory-specific SOP is available for all personnel on-site.

4: The data associated with the demonstration of capability are true, accurate, complete and self-explanatory (*). These data are attached to this certification statement.

5: All raw data (including a copy of this certificaton form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

Comments/ Observations: Prep Chemists: B. GINN, M. LOERA.

Karla Buechler
Technical Director

Technical Director Signature

Date: 7/15/11

Douglas Wein
QA Manager

QA Manager Signature

Date: 07/15/11

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TestAmerica — **West Sacramento**

[illegible] Proficiency Demonstration (DOC)

Note: Both averages are calculated based on the amount recovered, not the calculated (Recovery).
RSD's are calculated based on the amount recovered, not the calculated recovery.

Data Compliment:	6-Jun-11	Prep Analyst	
Method ID	1613B	Analytical Analyst: Mark Grandlickl	
Method Description	1613B	pg/L	SOP (include revision #) WS-IDP-0007 Rev. 1.3, WS-IC-0007 Rev. 3.5
Prep Method	Sep Funnel		

Analyte	Spike pg/L	Amount Recovered LCS 1 pg/L	LCS 2 pg/L	LCS 3 pg/L	LCS 4 pg/L	Percent Recovery LCS 1 %	LCS 2 %	LCS 3 %	LCS 4 %	AVE %	AVE. pg/L	RSD %	Control Limits Lower	Upper	RSD	
2,3,7,8-TCDF	200.000	234.235	209.460	215.380	194.810	117	105	108	97	107	213.484	7.6	75	158	50	ok
2,3,7,8-TCDD	200.000	218.492	211.573	214.629	188.639	109	106	107	94	104	219.019	6.0	67	158	50	ok
1,2,3,7,8-PeCDF	1000.000	1051.224	978.135	1007.853	1117.461	105	98	101	112	104	1051.428	5.4	80	134	50	ok
2,3,4,7,8-PeCDF	1000.000	1026.495	978.012	1064.704	1084.276	103	98	106	108	104	1044.118	4.9	68	160	50	ok
1,2,3,7,8-PeCDD	1000.000	1094.441	1008.934	994.696	1155.704	109	101	99	116	106	1099.259	10.1	70	142	50	ok
1,2,3,4,7,8-HxCDF	1000.000	1118.400	1082.117	1073.479	1084.178	111	108	107	108	109	1272.252	3.1	72	134	50	ok
1,2,3,6,7,8-HxCDF	1000.000	1120.142	1035.808	983.611	1009.491	112	104	98	101	104	1057.588	5.1	84	130	50	ok
2,3,4,6,7,8-HxCDF	1000.000	1118.312	1035.087	1001.696	1068.249	112	104	100	107	106	1078.086	3.2	70	156	50	ok
1,2,3,7,8,9-HxCDF	1000.000	1150.850	1034.101	1005.535	1067.178	115	103	101	107	106	1069.754	5.5	78	130	50	ok
1,2,3,4,7,8-HxCDD	1000.000	908.507	1081.764	977.466	1092.122	91	108	98	109	101	1094.508	9.1	70	164	50	ok
1,2,3,6,7,8-HxCDD	1000.000	1174.194	1092.997	1081.306	1111.978	118	109	108	111	111	1089.744	3.1	76	134	50	ok
1,2,3,7,8,9-HxCDD	1000.000	1048.511	1100.192	978.765	1163.703	105	110	98	116	107	1073.605	7.5	64	162	50	ok
1,2,3,4,6,7,8-HpCDF	1000.000	1022.111	1003.271	1046.314	1073.691	102	100	105	107	103	1035.893	2.9	82	122	50	ok
1,2,3,4,7,8,9-HpCDF	1000.000	1016.457	1003.402	1053.361	1053.692	102	100	105	105	103	1051.062	2.2	78	138	50	ok
1,2,3,4,6,7,8-HpCDD	1000.000	1239.053	1025.035	959.704	1068.294	124	103	96	107	107	1073.025	10.5	70	140	50	ok
OCDF	2000.000	2298.850	2098.973	2138.471	2459.227	114	105	107	123	112	2137.885	4.8	63	170	50	ok
OCDD	2000.000	2270.841	2071.833	2021.654	2184.153	113	104	101	109	107	2134.746	3.4	78	144	50	ok
13C-2,3,7,8-TCDF	3000.000	440.366	922.074	780.508	699.140	22	46	39	35	34	568.150	29.6	24	152	30	ok
13C-2,3,7,8-TCDD	3000.000	427.604	920.957	661.390	571.350	21	46	33	29	32	645.180	32.2	20	175	30	ok
13C-1,2,3,7,8-PeCDF	3000.000	464.547	931.010	995.601	572.504	23	62	31	29	36	662.890	36.0	21	192	30	ok
13C-2,3,4,7,8-PeCDF	3000.000	1136.810	1396.356	681.136	681.711	57	55	35	34	37	738.103	33.8	13	328	30	ok
13C-1,2,3,7,8-PeCDD	3000.000	469.722	1165.555	684.738	541.401	23	58	35	27	36	722.611	44.6	21	227	30	ok
13C-1,2,3,4,7,8-HxCDF	3000.000	711.279	981.348	902.134	782.770	36	49	45	39	40	594.674	19.6	19	202	30	ok
13C-1,2,3,6,7,8-HxCDF	3000.000	870.018	954.599	725.042	787.948	43	48	36	39	39	769.255	10.2	21	178	30	ok
13C-2,3,4,6,7,8-HxCDF	3000.000	672.928	1007.560	782.546	848.143	34	51	39	42	42	875.900	21.8	22	172	30	ok
13C-1,2,3,7,8,9-HxCDF	3000.000	701.496	1127.089	776.798	819.994	35	56	39	41	43	853.029	21.9	17	205	30	ok
13C-1,2,3,4,7,8-HxCDD	3000.000	845.365	968.027	494.956	657.364	42	48	25	33	43	825.926	15.2	23	140	30	ok
13C-1,2,3,6,7,8-HxCDD	3000.000	626.385	1168.101	671.548	732.457	31	58	34	37	40	784.511	31.7	26	123	30	ok
13C-1,2,3,4,6,7,8-HpCDF	3000.000	738.116	1195.303	680.095	654.015	37	60	34	33	41	825.353	23.0	9	139	30	ok
13C-1,2,3,4,7,8,9-HpCDF	3000.000	756.263	1139.015	666.478	675.481	38	56	33	34	40	821.068	23.0	20	136	30	ok
13C-1,2,3,4,6,7,8-HpCDD	3000.000	651.857	1144.846	687.641	620.501	33	57	34	30	39	780.555	31.2	28	166	30	ok
13C-OCDD	4000.000	1277.577	2149.513	1480.825	1575.553	32	54	37	39	40	1628.267	22.7	13	199	30	ok

1613 WATER (DOC mod) WIN11 DOC
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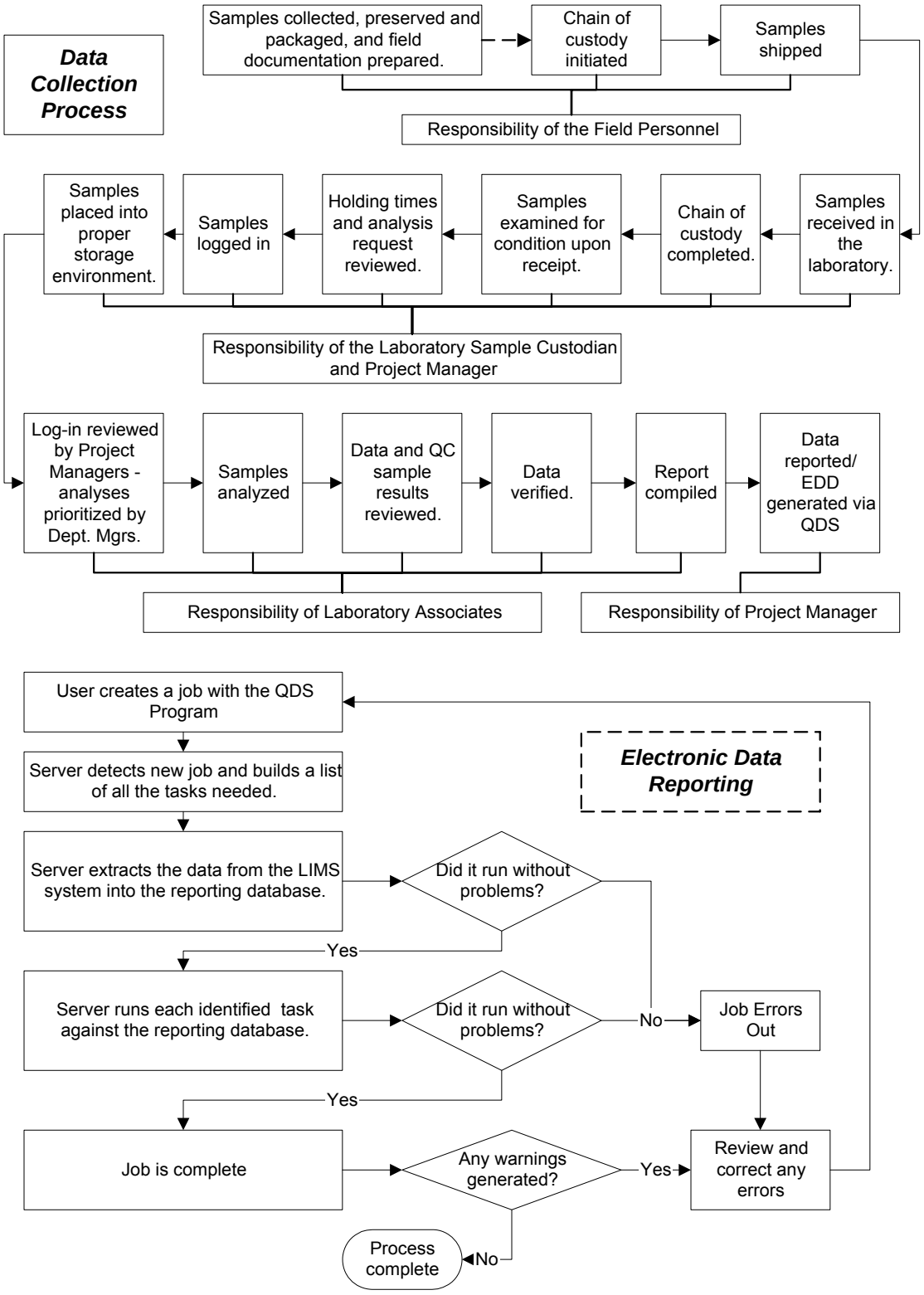
DOC Calculator
Version 6/20/2010

Figure 19-2. Example: Work Flow



SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Technical Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or

instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. See SOP No. WS-QA-0041, "Calibration and Calibration Check of Balances" for more details.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly**.**

The digital NIST thermometer is recalibrated every five years (choose based on thermometer type or insert your own frequency) (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in the SOP No. WS-QA-0016, "Thermometer Calibration."

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample storage are monitored 7 days a week; and each working day for units used for standard storage.

Ovens and waterbaths are monitored on days of use. Drying oven temperature must be recorded before and at the end of use. For example, an oven used for moisture determination must have its temperature recorded at the start and end of the drying process. Temperature must be ± 5% of set temperature for DoD work.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens, and waterbaths can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logbooks and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label is applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements. See SOP WS-QA-0004, “Maintenance and Calibration Check of Fixed and Adjustable Volume Autopipettors, Autodispensers and Volumetric Containers”.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an “Accuracy and Precision Statement of Conformance” from Hamilton attesting established accuracy.

20.3.6 Autoclaves

Autoclaves used for sample digestion are capable of maintaining conditions of 15 psi at 120ºC for 15 minutes. The temperature of the autoclave is verified quarterly.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day. Further details regarding the calculations involved are present in SOP No. CA-Q-S-005, “Calibration Curves (General).”

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually however, the annual requirement does not apply to Isotope Dilution methods.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with unacceptable calibration verification may be fully useable under the following special conditions, and reported based upon discussion and approval of the client:

a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the 2 conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used. Detailed calculations for each fitting method can be found in CA-T-P-002.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data

system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Example: Instrumentation List[1]

Instrument Type	Number in Use
Autoanalyzer	2
Autotitrator	1
Cold-Vapor Analyzers	2
GC/HRMS	8
GC/MS - Semivolatiles	6
GC/MS - Volatiles	5
GC/MS/MS	1
GC-ECD/ECD	7
GC-FID/FID	2
HPLC	5
HPLC/MS/MS	4
ICP	1
ICP/MS	2
Ion Chromatograph	3
Spectrometer	1
TOC Analyzer	1

Table 20-2. Example: Schedule of Routine Maintenance

INSTRUMENT	MAINTENANCE	FREQUENCY
APCI/ESI LC/MS/MS	Change pump seals. Change in-line filters in autosampler (HPLC). Check/replace in-line frit if excessive pressure or poor performance. Replace column if no change following in-line frit change. Clean corona needle. Replace sample inlet tube in APCI (10.1 cm). Replace fused silica tube in ESI interface. Clean lenses. Clean skimmer. Ballast rough pump 30 minutes.	As Needed
	Check solvent reservoirs for sufficient level of solvent. Verify that pump is primed, operating pulse free. Check needle wash reservoir for sufficient solvent. Verify capillary heater temperature functioning. Verify vaporizer heater temperature. Verify rough pump oil levels. Verify turbo-pump functioning. Verify nitrogen pressure for auxiliary and sheath gasses. Verify that corona and multiplier are functioning.	Daily(2)
	Replace rough-pump oil (4-6 months). Replace oil mist and odor elements. Replace activated alumina filter if applicable.	Semi-Annually
	Vacuum system components including fans and fan covers. Clean/replace fan filters, if applicable.	Annually
HIGH PRESSURE LIQUID CHROMATOGRAPH(1)	Replace columns when peak shape and resolution indicate that chromatographic performance of column is below method requirements. Rinse flow cell with 1N nitric acid if dirty flow cell. Change pump seals when flow becomes inconsistent. Backflush column if applicable. Change in-line filters for solvents.	As Needed
	Check level of solution in reservoirs. If adding, verify that solvent is from the same source. If changing, rinse delivery lines to prevent contamination of the new solvent. Check gas supply if applicable. Flush with an appropriate solvent to remove all bubbles. Pre-filter all samples.	Daily(2)
	Change pump seals.	Every 6-9 Months

INSTRUMENT	MAINTENANCE	FREQUENCY
GAS CHROMATOGRAPH(1)	Replace septum. Clean injector port Cut off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance (e.g. peak tailing, poor resolution, high backgrounds, etc.) indicates it is required. Change glass wool plug in injection port and/or replace injection port liner when front portion of capillary column is removed. Replace or repair flow controller if constant gas flow cannot be maintained. Detectors: clean when baseline indicates contamination or when response is low. FID: clean/replace jet, replace ignitor. ECD: follow manufacturers suggested maintenance schedule Replace fuse. Reactivate external carrier gas dryers. HP 7673 Autosampler: replace syringe, fill wash bottle, dispose of waste bottle contents. Check inlets, septa.	As Needed
	Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures. Check temperatures of injectors and detectors. Verify temperature programs. Check baseline level. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks.	Daily(2)
	ECD: perform wipe test.	Semi-Annually
PURGE AND TRAP SYSTEMS	Change trap. Check purge flow. Flush lines (after foaming sample). Periodic leak checks (when replace traps/spargers) Replace/condition traps and/or spargers (when poor response or disappearance of reactive or poorly trapped compounds), clean sample lines, valves (if they become contaminated), and clean or replace glassware/spargers. Bake trap as needed to correct for high background. Change trap whenever loss of sensitivity, or erratic response or failing resolution is observed. Purge & trap autosamplers: leak check system, clean sample lines, valves.	As Needed
	Bake out trap & analyze primers (as needed) prior to commencing analysis.	Daily(2)
GAS CHROMATOGRAPHY/LOW-RESOLUTION MASS SPECTROMETER(1)	Replace septum. Clean injector port. Cut off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance (e.g. peak tailing, poor resolution, high backgrounds, etc.) indicates it is required. Replace injection port liner when front portion of capillary column is removed. Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed. Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.	As Needed

INSTRUMENT	MAINTENANCE	FREQUENCY
	Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination. Replace filaments when both filaments burn out or performance indicates need for replacement. Check mass calibration (PFTBA or FC-43). Check ion source and analyzer (clean, replace parts as needed). Check vacuum, relays, gas pressures and flows. Change oil in the mechanical rough pump. Relubricate the turbomolecular pump-bearing wick. HP 7673 Autosampler: Replace syringe.	
	Check for sufficient gas supply. Check for correct column flow and/or inlet pressure. Check temperatures of injector, detector. Verify temperature programs. Check inlets, septa. Check baseline level. Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks. Autosampler: fill wash bottle, dispose of waste bottle contents.	Daily(2)
	Replace the exhaust filters on the mechanical rough pump every 1-2 years.	Annually
GAS CHROMATOGRAPHY/HIGH-RESOLUTION MASS SPECTROMETER(1)	Full Bake-Out. Change oil in rotary pump. Change oil in diffusion pump. Replace o-rings. Solvent rinse the flight tube. Clean the first field free region. Check detector voltages. Clean and dust connectors, etc on the outside of the instrument. Check the vacuum: ~5 x. 10^{-7} MBAR on both analyzer ion gauges, and ~5 x 10^{-6} MBAR on the source, with no helium flowing. Check isolation valve for leaks, correct if needed. Check for thermal trip by taking the magnet to maximum current, and verify that the coolant flow is acceptable. Replace septum. Clean injector port. Cut off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance (e.g. peak tailing, poor resolution, high backgrounds, etc.) indicates it is required. Replace injection port liner when front portion of capillary column is removed. Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination. Replace filaments when performance indicates need for replacement.	As Needed

INSTRUMENT	MAINTENANCE	FREQUENCY
	Check resolution sensitivity. Check stability. Check for sufficient gas supply. Check for correct column flow and/or inlet pressure. Check temperatures of injector, detector. Verify temperature programs. Check inlets, septa. Check baseline level. Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks.	Daily[2]
COLD VAPOR ATOMIC ABSORPTION (LEEMAN PS 200) [1]	Change pump tubing. Check/change Hg lamp. Clean optical cell. Change drying tube. Grease pump.	As Needed
	Check sample tip for clogs. Check drying tube. Check pump tubing/drain tubing. Check gas pressure. Check liquid/gas separator. Check tubing.	Daily[2]
INDUCTIVELY COUPLED ARGON PLASMA/MASS SPECTROMETRY (ICAP/MS)[1]	Check electronic settings for optimum sensitivity: resolution, mass calibration, ion optics. Measure quartz torch for proper alignment when removed and cleaned. Clean spray chamber and nebulizer. Clean all filters and fans. Check chiller coolant level. Check and drain oil mist eliminator on roughing pumps.	As Needed
	Check sample waste container level. Check quartz torch condition. Check RF coil. Check peristaltic pump: proper roller pressure, sample introduction tubing, correct pump rotation, condition of drain tubing. Check condition of sampler and skimmer cones. Check oil level of roughing pumps.	Daily[2]
	Replace oil in roughing pumps.	Every 2-3 Months
ICP[1]	Check that argon feed pressure is 80-120 psi. Check that chiller coolant pressure is 45-80 psig, no leaks. Check purge and shear gasses. Nitrogen purge gas pressure 40-120 psig, compressed air shear gas pressure 80-120 psig. Check radial purge and axial windows for deposits. Check that nebulizer is not clogged. Check that capillary tubing is clean and in good condition. Check that peristaltic pump windings are secure. Check that exhaust vent is operational Check that torch, glassware, aerosol injector tube are clean.	Daily[2]
	Clean plasma torch assembly to remove accumulated deposits. Check RF coil. Clean nebulizer and drain chamber; keep free flowing to maintain optimum performance.	Monthly or As Needed

INSTRUMENT	MAINTENANCE	FREQUENCY
	Clean filters on back of power unit to remove dust. Replace when needed: peristaltic pump tubing. sample capillary tubing. autosampler sipper probe. Check performance with manganese. Check O-rings. Clean/lubricate pump rollers	
	Check chiller coolant filter. (may require more or less frequently)	Semi-Annually
	Notify manufacturer service engineer for scheduled preventive maintenance service.	Annually
ION CHROMATOGRAPH(1)	Clean micromembrane suppressor when decreases in sensitivity are observed. Check fuses when power problems occur. Change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated. De-gas pump head when flow is erratic. Check all air and liquid lines for discoloration and crimping, if indicated. Check/change bed supports guard and analytical columns, if indicated.	As Needed
	Check plumbing/leaks. Check eluent level. Check gases. Check pump pressure. Check conductivity meter.	Daily(2)
	Check pump heads for leaks. Check filter (inlet).	Weekly
	Change pump seals. Change injection valve. Clean conductivity cell. Check conductivity cell for calibration.	Annually
ALPKEM COLORIMETRIC AUTO ANALYZER(1)	Prepare fresh reagents. Replace tubing. (About every 100 hours of use)	As Needed
	Check detector. Make sure there are no trapped bubbles in detector cell. Check Valves Check peristaltic tubing. Check sampler.	Daily(2)
	Clean pump, and XYZ Sampler.	Weekly
	Lubricate pump roller.	Monthly
	Clean pump rollers with steel wool and lubricate.	Semi-Annually
SYSTEA COLORIMETRIC AUTO ANALYZER(1)	Prepare fresh reagents. Replace waste tubing. Replace probes. Replace lamp	As Needed
	Perform washes. Perform filters autozero. Check temperatures.	Daily(2)
CHEMICAL OXYGEN DEMAND (COD) REACTOR(1)	Electronics serviced.	As Needed
	Check temperature with NIST reference thermometer.	Annually

INSTRUMENT	MAINTENANCE	FREQUENCY
AUTO TITRATOR[1]	Electronics serviced.	As Needed
	Calibrate with check standards. Inspect electrodes daily, clean as needed. Inspect electrode proper levels of filling solutions daily, fill as needed. Clean probe, each use. Prime buret Check rinse water reservoir.	Daily[2] (When Used)
CONDUCTANCE METER[1]	Electronics serviced. Replace batteries	As Needed
SPECTROPHOTOMETER[1]	Replace lamp. Replace fuse.	As Needed
	Check instrument manual. Perform wavelength calibration. Replace lamp annually or when erratic response is observed.	Annually
PH METER[1]	Clean electrode. Refill reference electrode.	As Needed
	Inspect electrode. Verify electrodes are properly connected and filled. Inspect electrode proper levels of filling solutions. Make sure electrode is stored in buffer.	Daily[2]
TOTAL ORGANIC CARBON ANALYZER (OI 1010 AND SOLIDS)	Check injection port septum after 50-200 runs. Perform leak test. Calibrate reagent pumps. Change sample loops. Adjust flow. Indicating drying tube. NDIR zero, after 100 hours of use. Sample pump, after 2000 hours for use. Digestion vessel/condensation chamber. Permeation tube, after 2000 hours of use. NDIR cell, after 2000 hours of use.	As Needed
	Check: Nitrogen supply, (oxygen supply for solids). Persulfate supply (1010 unit). Acid supply (1010 unit). Rinse water reservoir supply (1010 unit). IR millivolts for stability (after 30 min. warm-up).	Daily[2]
TURBIDIMETER[1]	Electronics serviced.	As Needed
	Clean instrument housing.	Monthly
DIGESTION BLOCK	Check temperature with NIST thermometer.	Annually
SONICATOR [1]	Replace probe tip. Disassemble and clean sonicator probe tips. Tune sonicator assembly (if recommended by manufacturer)	As Needed
	Inspect probe tips for inconsistencies (etching/pitting).	Daily[2] (When Used)
ANALYTICAL/TOP LOADING BALANCES[1]	Check using ASTM Class 3 weights once daily or before use. Clean pan and weighing compartment.	Daily[2]
REFRIGERATORS/WALK-IN COOLERS[1]	Manufacturer cleaning and calibration.	Annually
	Refrigerant system and electronics serviced.	As Needed
	Temperatures checked and logged.	Daily[2]

INSTRUMENT	MAINTENANCE	FREQUENCY
OVENS[1]	Electronics serviced.	As Needed
	Temperatures checked and logged.	Daily[2]
ZYMARK PE WORKSTATION	Change O-rings whenever there are visible leaks or poor sealing on the SPE columns. Sample lines are clean after samples have been extracted by SPE with a program "Clean Sample Lines" with methanol followed by water. Occasionally for a more rigorous cleaning, or after a highly contaminated sample, a mixture of methanol/DCM at 50:50 may be used in place of methanol, follow by methanol, then water (never use acetone). Syringe pump may be primed using a program "Prime Solvent Lines" whenever air bubbles are suspected in the lines from running out of solvents and whenever solvents are changed. Syringe pump in good condition – replace if showing signs of wear or suspected of poor performance. Sample pumps may be re-calibrated whenever major repairs are performed, or whenever the pumps are suspected to be out of calibration. Follow manufacturer's procedure for re-calibrating the sample pumps. For method 8330, the pump loads 1050 mL of sample on the SPE. It should used up the whole sample bottle (quart bottles and 1-L bottles).	As Needed
SONICATION WATER BATH[1]	If the water bath is dirty, empty and refill with tap water. A couple drops of anti-bacterial solution may be added to inhibit the growth of bacteria in the water. The water level in the sonication batch should be about 1.2 to 1 inch from the top while in operation. Do not allow sonication batch to operate with water bath at lower levels. If the level is low, add more water, if the levels is too high, remove water to the proper level.	As Needed

Footnotes to Preventive Maintenance Tables

(1) Refer to manufacturer's instructions for each instrument to identify and perform maintenance operations.

(2) Daily checks and verifications are performed prior to instrument startup and are not documented in maintenance logs unless problems are noted.

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

The calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to TestAmerica West Sacramento contains, in a well designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis upon which they were made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are

achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, TestAmerica West Sacramento does not use a firm who subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. [Refer to TestAmerica's Corporate SOP (CA-Q-S-001), Solvent and Acid Lot Testing and Approval.]

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the departments, and on the local server. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to method specific SOPs and SOP No. WS-QA-0017, "Standards and Reagent Preparation and Quality Control Check Procedures".

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material (for 1613B dioxin/furan analyses the purity must be 98% or corrections must be made).

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database or standards logbook.

- Standard ID
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)

- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically or in logbooks for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID (from the preparation logbook)
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in the MSDS section of OASIS.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions.
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However, there are some programs and regulators, such as the Alaska Department of Environmental Conservation, which determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative.

As soon as possible or “ASAP” is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory’s responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & subsampling are located SOP Nos. WS-QA-0018, “Subsampling and Compositing of Samples (Method ASTM D 6323-98**)**” and WS-QA-0028, “Multi-Incremental Subsampling of Soils and Sediments”.

Table 22-1.
Holding Times, Preservation and Container Requirements: Drinking Water (SDWA)

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.[23]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Asbestos	Plastic/Glass	4ºC	None	48 hours[5]	1 L
Coliforms (Total and Fecal)	Plastic/Glass[20]	10ºC	$Na_2S_2O_3$	30 hours[21]	120 mL
Cyanide	Plastic/Glass	4ºC	NaOH to pH >12 Ascorbic acid [9] or Sodium arsenite [9]	14 days	500 mL
Fluoride	Plastic/Glass	None	None	None	250 mL
Perchlorate (EPA 331.0)	Plastic/Glass[20]	4ºC	None Filtered, 1/3 Headspace to minimize anaerobic conditions	28 days	250 mL
Heterotrophic Plate Count	Plastic/Glass[20]	10ºC	$Na_2S_2O_3$	8 hours (24 hours[22])	120 mL
Mercury	Plastic/Glass	None	HNO_3 to pH<2	28 days	250 mL
Metals [4]	Plastic/Glass	None	HNO_3 to pH<2 [24]	6 months	250 mL
Nitrate	Plastic/Glass	4ºC	None	48 hours[6]	250 mL
Nitrate-Nitrite	Plastic/Glass	None	H_2SO_4 to pH<2	28 days	250 mL
Nitrite	Plastic/Glass	4ºC	None	48 hours	250 mL
THMs Only	Glass[8]	4ºC	$Na_2S_2O_3$ [9] HCl to pH <2 may also be used	14 days	3 X 40 mL
Volatile Organic Compounds	Glass[8]	4ºC	HCl to pH <2 $Na_2S_2O_3$ [9] or Ascorbic acid [9]	14 days / 24 hrs[25]	3 X 40 mL
EDB, DBCP, 1,2,3-TCP (EPA 504.1)	Glass[8]	4ºC	$Na_2S_2O_3$	14 days[11]	3 X 40 mL
Organochlorine Pesticides/PCBs (EPA 505)[10]	Glass[8]	4ºC	$Na_2S_2O_3$	14 days[11]	3 X 40 mL

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.[23]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Nitrogen and Phos. Pesticides (EPA 507)	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	14 days[12]	1 L
Total PCBs (EPA 508A)	Glass-Amber[8]	4ºC	None	14 days[13]	1 L
Pesticides and PCBs (EPA 508.1)[14]	Glass-Amber[8]	4ºC	HCl to pH <2 $Na_2S_2O_3$[9]	14 days[13]	1 L
Chlorinated Acids (EPA 515.1)	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	14 days[12]	1 L
Nitrosamines (EPA 521)	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	14 days[12]	1 L
Semivolatiles (EPA 525.2)	Glass-Amber[8]	4ºC	HCl to pH <2 $Na_2S_2O_3$[9]	14 days[13]	1 L
N-Methylcarbamoyloxamines and N-Methylcarbamates (EPA 531.1)	Glass[8]	4ºC	$Na_2S_2O_3$, Monochloroacetic Acid buffer to pH<3	28 days	3 X 60 mL
Acetamide Herbicide Degradates (EPA 535)	Glass-Amber[8]	4ºC	Ammonium Chloride	14 days[12]	250 mL
Glyphosate (EPA 547)	Glass[8]	4ºC	$Na_2S_2O_3$	14 days	3 X 60 mL
Endothall (EPA 548)	$Na_2S_2O_3$	4ºC	None	7 days[15]	1 L
Diquat/Parquat (EPA 549.1)	Glass-Amber[8] (Silanized or PVC amber)	4ºC	H_2SO_4 to PH <2 $Na_2S_2O_3$[9]	7 days[16]	1 L
Chlorinated Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides/Herbicides (EPA 551)	Glass[8]	4ºC	Phosphate Buffer and Ammonium Chloride[19]	14 days[17]	3 X 60 mL
Haloacetic Acids (EPA 552.1)	Glass-Amber[8]	4ºC	Ammonium Chloride	28 days[18]	250 mL
2,3, 7, 8 TCDD	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	1 year	1 L

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the

Key to Table

preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid, (HCl) in water, solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
4. All metals except Hg.
5. Instructions for containers, preservation procedures and holding times as specified in Method 100.2 must be adhered to for all compliance analysis including those conducted with Method 100.1.
6. If the sample is chlorinated, the holding time for an un-acidified sample kept at 4°C is extended to 14 days.
7. Nitrate-Nitrite refers to a measurement of total nitrite.
8. With Teflon lined septum.
9. If chlorinated, add reagent prior to acidification (for Cyanide, add before NaOH).
10. Heptachlor has a 7 day hold time.
11. 14 days until extraction. 24 hours after extraction.
12. 14 days until extraction. 28 days after extraction.
13. 14 days until extraction. 30 days after extraction.
14. For cyanazine, cool to 4°C only.
15. 7 days until derivitization. 1 day after derivitization.
16. 7 days until extraction. 21 days after extraction.
17. 14 days until extraction. 14 days after extraction.
18. 28 days until extraction. 48 hours after extraction.
19. Sodium Sulfite may be used as a dechlorinating agent in some instances. Verify with laboratory prior to sampling.
20. Sterilized. Plastic must be Polypropylene.
21. 40 CFR part 141.74 regulations to avoid filtration or disinfection state 8 hours (DW compliance testing). Most facilities are using either disinfection or filtration so the 8 would not apply in most cases.
22. 40 CFR part 141.74 regulations for Disinfection By-Product rule state 8 hours (DW compliance testing) where SM 9215 allows up to 24 hours if sample is stored between > 0 and $\leq$ 4° C.
23. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to $\leq$ 6°C is acceptable.
24. Acid preservation may be omitted for shipping and laboratory will acidify at least 24 hours prior to analysis.
25. Holding Time is 24 hours if pH adjustment is not performed.

Table 22-2
Holding Times, Preservation and Container Requirements: NPDES – Bacteria, Protozoa, Toxicity Tests

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Total, Fecal, and E.coli Coliforms	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Fecal Streptococci	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Enterococci	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Cryptosporidium	LPDE Plastic	0-8ºC	None	96 Hours	500 mL
Giardia	LPDE Plastic	0-8ºC	None	96 Hours	500 mL
Toxicity – Acute/Chronic	Plastic/Glass	$\leq$ 6ºC[5]	None	36 Hours	2 L

Key to Table

1. Plastic should be Polypropylene or other sterilizable plastic.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid, (HCl) in water, solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. Samples must not be frozen. Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present, when samples arrive, it is necessary to measure the temperature of the samples and confirm that the $\leq$ 6°C temperature has not been exceeded.
6. Should only be used in the presence of residual chlorine.

Table 22-3
Holding Times, Preservation and Container Requirements: NPDES - Inorganic

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp[14].	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Acidity	Plastic/Glass	≤ 6ºC	None	14 days	100 mL
Alkalinity	Plastic/Glass	≤ 6ºC	None	14 days	100 mL
Ammonia	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH<2	28 days	400 mL
BOD 5 Day	Plastic/Glass	≤ 6ºC	None	48 hours	1000 mL
Boron	Plastic[5]	None	HNO_3 to pH<2	6 months	200 mL
Bromide	Plastic/Glass	None	None	28 days	100 mL
CBOD 5 Day	Plastic/Glass	≤ 6ºC	None	48 hours	1000 mL
COD	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH<2	28 days	100 mL
Chloride	Plastic/Glass	None	None	28 days	50 mL
Chlorine, Residual	Plastic/Glass	None	None	15 min.[6]	200 mL
Color	Plastic/Glass	≤ 6ºC	None	48 hours	50 mL
Cyanide –Total [16, 17]	Plastic/Glass	≤ 6ºC	NaOH to pH >12, 0.6 g Ascorbic Acid[7]	14 days	100 mL
Cyanide – Amenable [16, 17]	Plastic/Glass	≤ 6ºC	NaOH to pH >12, 0.6 g Ascorbic Acid[7]	14 days	100 mL
Fluoride	Plastic	None	None	28 days	300 mL
Hardness	Plastic/Glass	None	HNO_3 to pH<2[8]	6 months	100 mL
Hexavalent Chromium	Plastic/Glass	≤ 6ºC	Ammonium sulfate buffer pH = 9.3 - 9.7	28 days / 24 hrs[15]	200 mL
Hydrogen Ion (pH)	Plastic/Glass	None	None	15 min.[6]	200 mL
Kjeldahl and organic Nitrogen	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	500 mL
Mercury[11]	Plastic/Glass	None	HNO_3 to pH<2	28 days	200 mL
Metals[9,10]	Plastic/Glass	None	HNO_3 to pH<2 [18]	6 months	200 mL
Nitrate	Plastic/Glass	≤ 6ºC	None	48 hours	100 mL
Nitrate-Nitrite	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	100 mL
Nitrite	Plastic/Glass	≤ 6ºC	None	48 hours	100 mL
Oil and Grease	Glass	≤ 6ºC	H_2SO_4 or HCl to pH <2	28 days	1 L

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp[14].	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Organic Carbon (TOC)	Plastic/Glass	≤ 6ºC	H_2SO_4 or HCl to pH <2[12]	28 days	250 mL
Orthophosphate	Plastic/Glass	≤ 6ºC	Filter within 15 min.	48 hours	250 mL
Oxygen, Dissolved Probe	Glass[13]	None	None	15 min.[6]	200 mL
Oxygen, Winkler	Glass[13]	None	Fix on site and store in dark.	8 hours	300 mL
Phenols	Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	500 mL
Phosphorus, Elemental	Glass	≤ 6ºC	None	48 hours	250 mL
Phosphorus, Total	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	250 mL
Residue, Total	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Filterable	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Non-Filterable	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Settleable	Plastic/Glass	≤ 6ºC	None	48 hours	1 L
Residue, Volatile	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Silica	Plastic[5]	≤ 6ºC	None	28 days	250 mL
Specific Conductance	Plastic/Glass	≤ 6ºC	None	28 days	250 mL
Sulfate	Plastic/Glass	≤ 6ºC	None	28 days	250 mL
Sulfide	Plastic/Glass	≤ 6ºC	Zinc acetate plus NaOH to pH>9	7 days	500 mL
Sulfite	Plastic/Glass	None	None	15 min.[6]	200 mL
Surfactants	Plastic/Glass	≤ 6ºC	None	48 hours	1 L
Temperature	Plastic/Glass	None	None	N/A	100 mL
Turbidity	Plastic/Glass	≤ 6ºC	None	48 hours	1 L

Key to Table

1. Plastic should be Polyethylene.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at ≤ 6ºC until compositing and sample splitting is completed.

Key to Table

3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid, (HCl) in water, solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. May also be collected in quartz or PFTE Plastic.
6. For compliance testing, the analysis must be performed in the field at the time of analysis. If transported to the laboratory for analysis, the analysis will be performed as soon as practical and reported qualified.
7. Should only be used in the presence of residual chlorine. (Alternatively, sodium arsenite may be used.)
8. H_2SO_4 to a pH <2 is also acceptable.
9. Except Mercury and Hexavalent Chromium.
10. For dissolved metals, samples must be filtered on site before adding HNO_3 preservative (or before shipping to laboratory).
11. Samples collected for determination of trace level mercury (100 ng/L) using EPA 1631 must be collected in tightly capped Fluor polymer or glad bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. Samples collected for dissolved trace level mercury should be filtered in the laboratory. However, if circumstances prevent overnight shipping, samples should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. Samples that been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.
12. Phosphoric acid (H_3PO_4) may also be used.
13. Should have glass lid or top.
14. Aqueous samples must be preserved at ≤6 °C unless otherwise indicated, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of ‘‘≤ °C’’ is used in place of the ‘‘4 °C’’ and ‘‘<4 °C’’ sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).
15. Holding time is 24 hours if pH adjustment is not performed.
16. In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH. If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered (with sulfide treatment by laboratory) and qualify the results in the final report.
17. It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.
18. Acid preservation may be omitted for shipping and laboratory will acidify at least 24 hours prior to analysis.

Table 22-4
Holding Times, Preservation and Container Requirements: NPDES - Organic

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.[15]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Purgeable Halocarbons	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	14 days	40 mL
Purgeable Aromatic Hydrocarbons	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5], HCl to pH<2	14 days[6]	40 mL
Acrolein and Acrylonitrile	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5], adjust pH to 4-5[7]	14 days	40 mL
Phenols[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8]	1 L
Benzidines[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8, 11]	1 L
Phthalate esters[9]	Glass[4]	≤ 6ºC	None	7 days[8]	1 L
Nitrosamines[9,12]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
PCBs[9]	Glass[4]	≤ 6ºC	None	1 year[8]	1 L
Nitroaromatics and Isophorone[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
Polynuclear Aromatic Hydrocarbons[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
Haloethers[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8]	1 L
Chlorinated Hydrocarbons[9]	Glass[4]	≤ 6ºC	None	7 days[8]	1 L
CDD/CDFs[9] – Aqueous: Field/Lab Preservation	Glass	≤ 6ºC	pH <9, 0.0008 % $Na_2S_2O_3$[5]	1 year	1 L
CDD/CDFs[9] – Solids/Mixed Phase/ - Field Preservation	Glass	≤ 6ºC	None	7 days	1 L
CDD/CDFs[9] – Tissue – Field Preservation	Glass	≤ 6ºC	None	24 hours	
CDD/CDFs[9] – Solids/Mixed Phase/Tissue - Lab Preservation	Glass	< -10ºC	None	1 year	1 L
Pesticides[9]	Glass	≤ 6ºC	pH 5-9 [14]	7 days[8]	1 L

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at $\leq 6^{o}C$ until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid, (HCl) in water, solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
4. With Teflon lined septum.
5. Should only be used in the presence of residual chlorine. Ascorbic may be used instead.
6. Samples receiving no pH adjustments must be analyzed within 7 days. If 2-chlorovinylethylether is a target analyte, the sample should not be acidified.
7. The pH adjustment is not required if acrolein is not being measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.
8. 7 days until extraction, 40 days after extraction. (PCB only – 1 year after extraction)
9. When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more categories, the sample may be preserved by cooling to $\leq 6^{o}C$ reducing residual chlorine with 0.0008 % sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9. Samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine) and footnotes 10 and 11(re the analysis of Benzidine).
10. If 1,2-diphenylhydrazine is likely to be present, adjust pH to of the sample to 4.0 $\pm$ 0.2 to prevent rearrangement to benzidine.
11. Extracts may be stored up to 30 days before analysis if storage temperature is $< 0^{o}C$.
12. For the analysis of diphenylnitrosamine, add 0.008 % $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
13. Store in dark.
14. The pH adjustment may be performed upon receipt in the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.0008 % $Na_2S_2O_3$.
15. Aqueous samples must be preserved at ≤6 °C unless otherwise indicated, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of ‘‘≤ °C’’ is used in place of the ‘‘4 °C’’ and ‘‘<4 °C’’ sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).

Table 22-5.
Holding Times, Preservation and Container Requirements: NPDES - Radiological

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Alpha, Beta, Radium	Plastic/Glass	None	HNO_3 to pH<2	6 months	1 L

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater).
3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Table 22-6.
Holding Times, Preservation and Container Requirements: RCRA - Aqueous

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[12]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Chloride	Plastic/Glass	4ºC	None	28 days	100 mL
Cyanide -Total	Plastic/Glass	4ºC	NaOH to pH >12[5]	14 days	250 mL
Cyanide -Amenable	Plastic/Glass	4ºC	NaOH to pH >12[5]	14 days	250 mL
Hydrogen Ion (pH)	Plastic/Glass	4ºC	None	24 hours[11]	100 mL
Nitrate	Plastic/Glass	4ºC	None	48 hours	28 days
Oil and Grease	Glass	4ºC	HCl	28 days	1 L
Organic carbon (TOC)	Plastic/Glass	4ºC	pH to <2[6] Store in dark	28 days	28 days
Sulfate	Plastic/Glass	4ºC	None	28 days	400 mL
Sulfide	Plastic/Glass	4ºC	Add Zn Acetate	7 days	400 mL
Chromium VI	Plastic/Glass	4ºC	None	24 hours	250 mL
Mercury	Plastic/Glass	None	HNO_3 to pH<2	28 days	250 mL
Other Metals	Plastic/Glass	None	HNO_3 to pH<2[15]	6 months	250 mL
Acrolein and Acrylonitrile	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7] Adjust pH to 4-5[13]	14 days	1 L
Benzidines	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Chlorinated Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Dioxins and Furans	Glass[10]	4ºC	None	30 days[8]	1 L
Haloethers	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Nitroaromatics and cyclic ketones	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Nitrosamines	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Organochlorine Pesticides	Glass[10]	4ºC	None	7 days[8]	1 L
Organophosphorus Pesticides	Glass[10]	4ºC	Adjust pH[9]	7 days[8]	1 L
PCBs	Glass[10]	4ºC	None	None[14]	1 L
Phenols	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[12]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Phthalate Esters	Glass[10]	4ºC	None	7 days[8]	1 L
Polynuclear Aromatic Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Purgeable Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7] Adjust pH <2[2]	14 days	40 mL
Purgeable Halocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	14 days	40 mL
Total Organic Halides (TOX)	Glass[10]	4ºC	Adjust pH to <2 with H_2SO_4	28 days	1 L
Radiological Tests (Alpha, Beta, Radium)	Plastic/Glass	None	HNO_3 to pH<2	6 months	250 mL

Key to Table

1. Plastic should be Polyethylene.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid, (HCl) in water, solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. If oxidizing agents are present, add 5 mL 0.1 N $NaAsO_2$ or 0.06 g of ascorbic acid per L. See Cyanide SOP for additional information about other interferences.
6. Adjust pH to <2 with H_2SO_4, HCl, or solid $NaHSO_4$. Free Chlorine must be removed prior to adjustment.
7. Free Chlorine must be removed by the appropriate addition of $Na_2S_2O_3$.
8. 7 days until extraction. 40 days after extraction.
9. Adjust pH to 5-8 using NaOH or H_2SO_4.
10. With Teflon lined septum.
11. Holding Time is listed as “As Soon as Possible” in SW 846. Per EPA MICE, the recommended maximum holding time for pH in water is 24 hours and pH in soil is 7 days. There are no mandated regulatory requirements.
12. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to $\leq$ 6°C is acceptable.
13. Based on guidance from EPA MICE, if samples are received without pH adjustment, the holding time is 7 days.
14. Analysis to be completed within 40 days after extraction.
15. Acid preservation may be omitted for shipping and laboratory will acidify at least 24 hours prior to analysis.

Table 22-7.
Holding Times, Preservation and Container Requirements: RCRA – Non-Aqueous

PARAMETER	CONTAINER [1]	PRESERVATION Temp.[7]	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Chloride	Glass	4ºC	None	28 days	50 g
Cyanide -Total	Glass	4ºC	None	14 days	50 g
Cyanide - Amenable	Glass	4ºC	None	14 days	50 g
Hydrogen Ion (pH)	Glass	4ºC	None	7 days[6]	50 g
Nitrate	Glass	4ºC	None	N/A	50 g
Oil and Grease	Glass	4ºC	None	28 days	50 g
Sulfide	Glass	4ºC	Add Zn Acetate, zero headspace	7 days	50 g
Chromium VI	Glass	4ºC	None	30 days	50 g
Mercury	Plastic/Glass	None	None	28 days	50 g
Other Metals	Plastic/Glass	None	None	6 months	50 g
Acrolein and Acrylonitrile	Glass[4]	4ºC	None	14 days	50 g
Benzidines	Glass[4]	4ºC	None	14 days[3]	50 g
Chlorinated Hydrocarbons	Glass[4]	4ºC	None	14 days[3]	50 g
Dioxins and Furans	Glass[4]	4ºC	None	30 days[3]	50 g
Haloethers	Glass[4]	4ºC	None	14 days[3]	50 g
Nitroaromatics and cyclic ketones	Glass[4]	4ºC	None	14 days[3]	50 g
Nitrosamines	Glass[4]	4ºC	None	14 days[3]	50 g
Organochlorine Pesticides	Glass[4]	4ºC	None	14 days[3]	50 g
Organophosphorus Pesticides	Glass[4]	4ºC	None	14 days[3]	50 g
PCBs	Glass[4]	4ºC	None	None[8]	50 g
Phenols	Glass[4]	4ºC	None	14 days[3]	50 g
Phthalate Esters	Glass[4]	4ºC	None	14 days[3]	50 g
Polynuclear Aromatic Hydrocarbons	Glass[4]	4ºC	None	14 days[3]	50 g

PARAMETER	CONTAINER [1]	PRESERVATION Temp.[7]	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Purgeable Hydrocarbons	Glass[4]	4ºC	None	14 days[5]	50 g
Purgeable Halocarbons	Glass[4]	4ºC	None	14 days[5]	50 g
Total Organic Halides (TOX)	Glass[4]	4ºC	None	28 days	50 g

Key to Table

1. Plastic should be Polyethylene.
2. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
3. 14 days until extraction. 40 days after extraction.
4. With Teflon Lined Septum.
5. See Volatile SOP for more detailed preservation requirements.
6. Holding Time is listed as “As Soon as Possible” in SW 846. Per EPA MICE, the recommended maximum holding time for pH in water is 24 hours and pH in soil is 7 days. There are no mandated regulatory requirements.
7. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to $\leq$ 6°C is acceptable.
8. Analysis to be completed within 40 days after extraction.

Table 22-8.
Holding Times, Preservation and Container Requirements: Air Samples

PARAMETER	CONTAINER [1]	PRESERVATION Temp.	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Volatile Organics	Summa Canister	None	None	30 days	6L or 1L
Volatile Organics	Tedlar Bag	None	None	72 hrs[3,4]	1 L

Key to Table

1. Plastic should be Polyethylene.
2. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
3. Holding Time is based on SW 846 Method 0040 “SAMPLING OF PRINCIPAL ORGANIC HAZARDOUS CONSTITUENTS FROM COMBUSTION SOURCES USING TEDLAR® BAGS”. Some states specifically enforce this holding time (e.g. Florida, New Jersey) and others have not specified this information in their regulatory requirements.
4. The holding time is 72 hours unless the laboratory has a documented validation study that indicates a longer HT is acceptable for the analytes of interest.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The

sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the CoC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, legal COCs will be generated per the Manual for Certification of Laboratories Analyzing Drinking Water, Fifth Edition, January 2005, Appendix A, and SOP No. WS-QA-0003, "Sample Receipt and Procedures".

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections and in SOP No. WS-QA-0003, "Sample Receipt and Procedures".

23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on the lot receipt checklist and within the non-conformance program and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record. Laboratory receipt procedures are described in more detail in SOP No. WS-QA-0003.

23.2.1.1 Unique Sample Identification

When samples arrive at the laboratory, they are assigned a tracking ID consisting of the Lot ID and a sample number. The lot ID is a 9 character alphanumeric identifier, with the composition as follows:

Character Position	Valid Values	Significance
First	"G"	Assigned to TestAmerica West Sacramento, to distinguish from other laboratories using the Quantims LIMS.
Second	0-9	Last digit of the year in which the samples are received.
Third	A – L	Corresponds to the month in which the samples are received. A = January, B= February, etc.
Fourth & Fifth	01 – 31	Corresponds to the day of the month in which samples are received.
Sixth	0	Separator between day and sequence values.
Seventh through Ninth	400 – 999	Sequence value denoting the order in which lots were logged into Quantims on a given day. Each lot will have a unique sequence number, no matter which Quantims Laboratory logged in the lot.

From the table above, the lot ID G0F100544 is for TestAmerica West Sacramento, logged in in 2010, June, the tenth day, and sequence number 544 for that day.

Once a lot ID is assigned and samples are individually logged in, a workorder(5) and bottle number are assigned to each container. In addition, workorder(8) values are assigned for each analysis requested. The workorder(8) is used to distinguish extracts and digestates produced from the sample. The workorder(5) consists of 5 alphanumeric characters assigned by the LIMS. The LIMS assigns these values sequentially as samples are logged in across the network, using 0-9, and letters of the alphabet excluding "B", "O" and "I", as these may be mistaken for numbers. In addition, sample containers are labeled with the lot ID and a sample number (from 1 to 99).

The workorder(8) consists of the workorder(5), plus 3 additional alphanumeric characters, beginning with "1AA". The first digit of the additional characters denotes the analysis number, such that "1" is the first analysis, "2" is a reanalysis, etc. The second and third characters are assigned sequentially as test requests are added to the sample.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP No. WS-QA-0003.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples are returned to the secure sample control area. Empty sample containers are marked as “DIT” (destroyed in testing) on the sample receiving check out form and are disposed by the analytical staff. All samples are kept in the refrigerators for 30 days past invoicing, unless other arrangements have been made with the client.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only.

Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

Foreign soil samples are sent out for incineration by a USDA-approved waste disposal facility.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

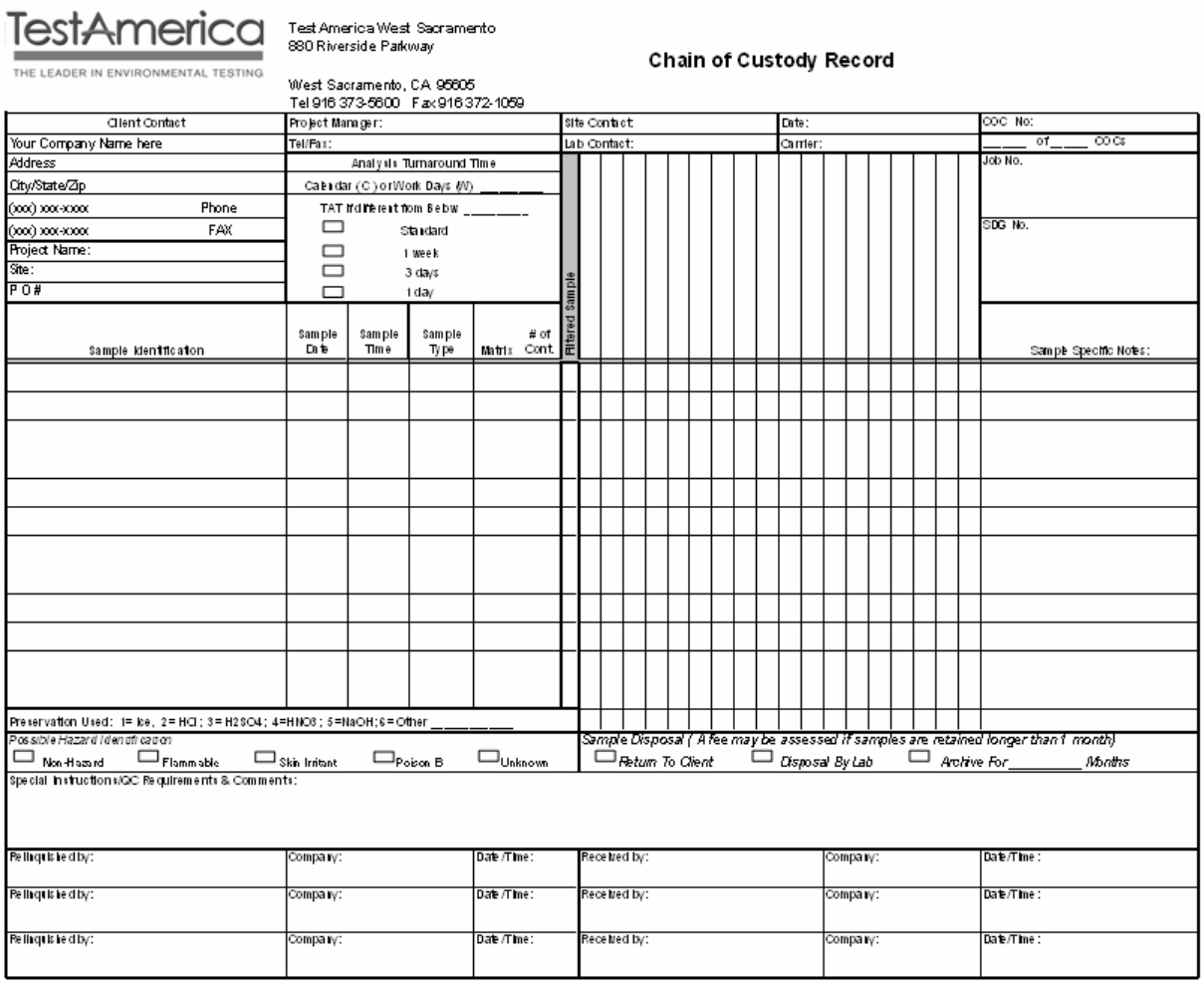
23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: WS-EHS-001, "Waste Disposal"). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or

deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1. Example: Chain of Custody (COC)



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880 Riverside Parkway
West Sacramento, CA 95605
Tel 916 373-5600 Fax 916 372-1059

Chain of Custody Record

Client Contact	Project Manager:	Site Contact:	Date:	COC No:
Your Company Name here	Tel/Fax:	Lab Contact:	Carrier:	____ of ____ COCs
Address	Analysis Turnaround Time			Job No.
City/State/Zip	Calendar (C) or Work Days (W) _____			
(xxx) xxx-xxxx Phone	TAT if different from Below _____			SDG No.
(xxx) xxx-xxxx FAX	☐ Standard			
Project Name:	☐ 1 week			
Site:	☐ 3 days			
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Figure 23-2. Example: Sample Acceptance Policy

NELAC and TestAmerica West Sacramento have specific requirements under which all samples will be received by the laboratory for analysis. TestAmerica West Sacramento will review your sample shipment against those requirements as listed below, and will communicate any discrepancies to you. Your project manager will assist you in the appropriate resolution of any issues related to sample receipt. Please contact your project manager with any questions.

TestAmerica West Sacramento requirements are as follows:

- ✓ Proper, full and complete documentation, which includes sample identification, the location, date and time of collection, the collector's name, the preservation type, the sample matrix type, the requested testing method, and any special remarks concerning the samples, shall be provided.
- ✓ Samples must be accompanied by written disclosure of the known or suspected presence of any hazardous substances, as defined by applicable federal or state law.
- ✓ Each sample shall be collected in the appropriate sample container and labeled with unique, durable and indelible identification.
- ✓ Drinking waters samples for Method 1613B that may have residual chlorine must be checked and treated in the field, or collected in sodium thiosulfate preserved containers.
- ✓ The samples shall arrive at the laboratory with adequate remaining holding time for the analyses requested.
- ✓ Sufficient sample volume must be available to perform the requested analyses.
- ✓ Received samples must not exhibit obvious signs of damage, contamination or inadequate preservation.
- ✓ For samples undergoing chemical warfare degradate analysis, the sample must be screened for agent prior to shipment in accordance with appendix 10 of our Sample Receipt Procedure (WS-QA-0003).
- ✓ Samples containing mammalian tissue will not be accepted without prior coordination with a project manager. Additional conditions for receipt and handling of tissue are outlined in appendix 11 of our Sample Receipt Procedure (WS-QA-0003).

The laboratory will notify the client/Project Manager upon sample receipt if the samples fail to meet any of the above requirements.

When completing the chain of custody form, please do not forget to sign your name in the "relinquished by" box.

Figure 23-3. Example: Cooler Receipt Form

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LOT RECEIPT CHECKLIST
TestAmerica West Sacramento

CLIENT _____ PM_____ LOG # _____

LOT# (QUANTIMS ID) _____ QUOTE#_____ LOCATION_____

Checked (✓)

DATE RECEIVED _____ TIME RECEIVED_____ ☐

DELIVERED BY ☐ FEDEX ☐ ON TRAC ☐ CLIENT
☐ GOLDENSTATE ☐ UPS ☐ GO-GETTERS ☐ OTHER

☐ TAL COURIER ☐ TAL SF ☐ VALLEY LOGISTICS ☐

CUSTODY SEAL STATUS ☐ INTACT ☐ BROKEN ☐ N/A ☐

CUSTODY SEAL #(S) _____

SHIPPPING CONTAINER(S) ☐ TAL ☐ CLIENT ☐ N/A ☐

COC #(S)_____ ☐

TEMPERATURE BLANK Observed:_____ Corrected:_____

SAMPLE TEMPERATURE - (TEMPERATURES ARE IN °C)

Observed:_____ Average_____ Corrected Average_____

LABORATORY THERMOMETER ID:

IR UNIT: #4 ☐ #5☐ ☐ OTHER_____ ☐

Initials	Date
_____	_____

==========

pH MEASURED ☐ YES ☐ ANOMALY ☐ N/A ☐
LABELED BY..... ☐
LABELS CHECKED BY..... ☐
PEER REVIEW _____ ☐ NA

SHORT HOLD TEST NOTIFICATION
SAMPLE RECEIVING ☐
WETCHEM ☐ N/A ☐
VOA-ENCORES☐ N/A ☐

☐ METALS NOTIFIED OF FILTER/PRESERVE VIA VERBAL & EMAIL ☐ N/A ☐

☐ COMPLETE SHIPMENT RECEIVED IN GOOD CONDITION WITH ☐ N/A ☐
APPROPRIATE TEMPERATURES, CONTAINERS, PRESERVATIVES

☐ CLOUSEA ☐ TEMPERATURE EXCEEDED (2 °C – 6 °C)*1 ☐ N/A
☐ WET ICE ☐ BLUE ICE ☐ GEL PACK ☐ NO COOLING AGENTS USED ☐ PM NOTIFIED

Initials	Date
_____	_____

Notes_____

*1 Acceptable temperature range for State of Wisconsin samples is ≤4°C.

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TestAmerica
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Bottle Lot Inventory

Lot ID:_____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
VOA*																				
VOAh*																				
AGB																				
AGBs																				
250AGB																				
250AGBs																				
250AGBn																				
500AGB																				
____AGJ																				
500AGJ																				
250AGJ																				
125AGJ																				
____CGJ																				
500CGJ																				
250CGJ																				
125CGJ																				
PJ																				
PJn																				
500PJ																				
500PJn																				
500PJna																				
500PJzn/na																				
250PJ																				
250PJn																				
250PJna																				
250PJzn/na																				
Acetate Tube																				
_____"CT																				
Encore																				
Folder/filter																				
PUF																				
Petri/Filter																				
XAD Trap																				
Ziploc																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

h = hydrochloric acid s = sulfuric acid na = sodium hydroxide n = nitric acid zn = zinc acetate

Number of VOAs with air bubbles present / total number of VOA's

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [1]	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous

volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
-
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB Aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the Aroclors. Specific Aroclors may be used by request on a project specific basis.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects.If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

- The maximum acceptable recovery limit will be 150%. Some specific methods or SOPs may allow for higher recoveries.

- The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 10%.

- If either the high or low end of the control limit changes by ≤ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. See Policy WS-PQA-003 for further details.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI and Department Of Defense (DOD) work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).

- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedences may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additonal Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed or prepared electronically on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Analytical Report For Samples) with a "sample results" column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. work order number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##, where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.
- In most cases, the applicable COC is an integral part of the report.
- Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g., Sampling information).

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

25.2.11 Reporting limit.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.22 The laboratory includes a cover letter.

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 A clear statement notifying the client that non-accredited tests were performed and directing the client to the laboratory's accreditation certificates of approval shall be provided when non-accredited tests are included in the report.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level II is a report with the features described in Section 25.2 above, plus summary information, including results for the method blank reported to the laboratory MDL if required, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. No raw data is provided unless it is necessary to provide the relevant calibration information.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in electronic deliverable form via e-mail, posting to an FTP site, or CD ROM. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica West Sacramento offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD, and a copy filed on the QA share of the local server.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This

necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationery and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

> *This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by telephone at the 1-916-373-5600*

(or for e-mails: please notify us immediately by e-mail or by phone (1-916-373-5600) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the sample number followed by "Amend". The revised report will have the word "revised" or "amended" next to the date in the footer.

When the report is re-issued, a notation of "Amended" is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/11 to include toluene in sample NQA1504 per client's request. This final report replaces the final report generated on 10/27/11.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

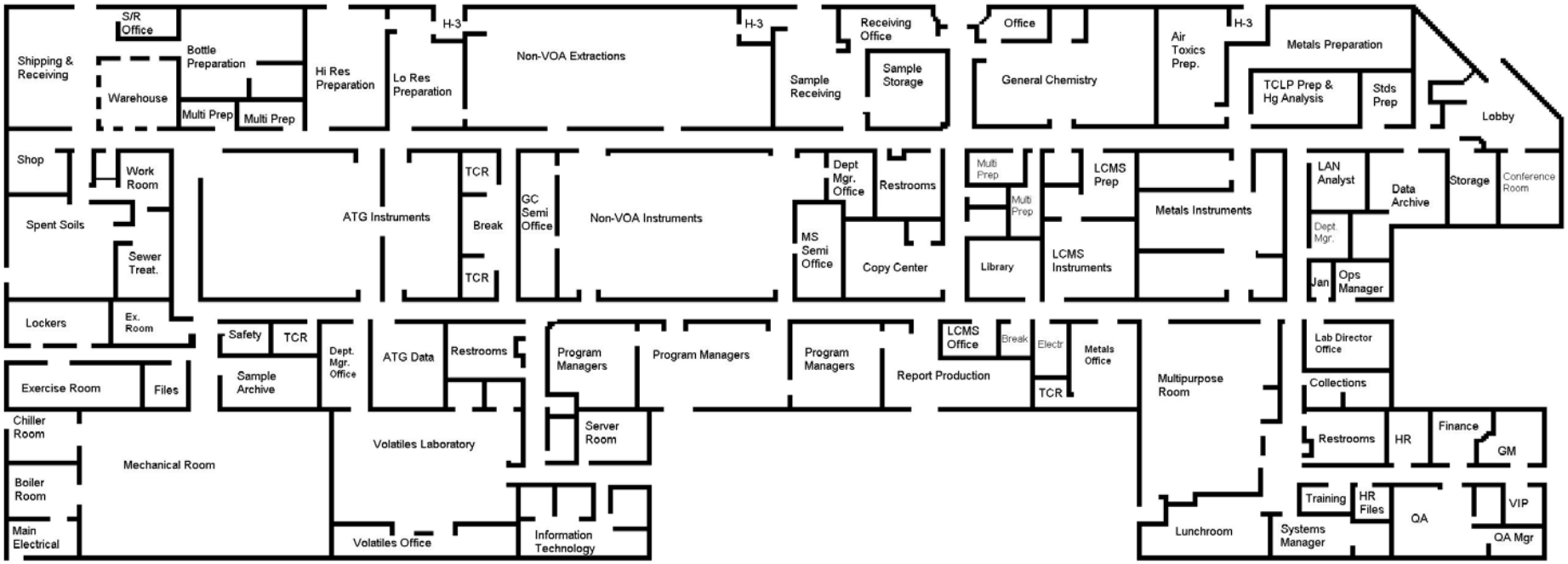
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Facility Size	Square Feet
Total Area	66,000
Lab Area	43,000
Storage Area	5,200
	Linear Feet
Bench Top	3,000
Hoods	500

Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

> *Aqueous:* Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater, effluents, and TCLP or other extracts.
>
> *Drinking Water:* Any aqueous sample that has been designated as a potable or potential potable water source.
>
> *Saline/Estuarine:* Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
>
> *Non-Aqueous Liquid:* Any organic liquid with <15% settleable solids.
>
> *Biological Tissue:* Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
>
> *Solids:* Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
>
> *Chemical Waste:* A product or by-product of an industrial process that results in a matrix not previously defined.
>
> *Air & Emissions:* Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test

result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

A2LA – American Association for Laboratory Accreditation
ANSI – American National Standards Institute
ASQ – American Society for Quality
CAR – Corrective Action Report
CCB – Continuing Calibration Blank
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICB – Initial Calibration Blank
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica West Sacramento maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

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TestAmerica Certifications

Laboratory	Program	Authority	Identification	Expiration Date
TestAmerica West Sacramento	Alaska UST	Alaska	UST-055	12/08/2011
TestAmerica West Sacramento	DoD ELAP	A2LA	2928-01	01/31/2012
TestAmerica West Sacramento	NELAC	California	1119CA	01/31/2012
TestAmerica West Sacramento	NELAC	Florida	E87570	06/30/2011
TestAmerica West Sacramento	NELAC	Illinois	200060	03/17/2012
TestAmerica West Sacramento	NELAC	Kansas	E-10375	10/31/2011
TestAmerica West Sacramento	NELAC	Louisiana	30612	06/30/2011
TestAmerica West Sacramento	NELAC	New Jersey	CA005	06/30/2012
TestAmerica West Sacramento	NELAC	New York	11666	04/01/2012
TestAmerica West Sacramento	NELAC	Oregon	CA200005	03/28/2012
TestAmerica West Sacramento	NELAC	Pennsylvania	68-01272	03/31/2012
TestAmerica West Sacramento	NELAC	Texas	T104704399-08-TX	05/31/2012
TestAmerica West Sacramento	NELAC	Utah	QUAN1	01/31/2012
TestAmerica West Sacramento	State Program	Arizona	AZ0708	08/11/2012
TestAmerica West Sacramento	State Program	Arkansas	88-0691	06/17/2011
TestAmerica West Sacramento	State Program	Colorado	N/A	08/31/2011
TestAmerica West Sacramento	State Program	Connecticut	PH-0691	06/30/2011
TestAmerica West Sacramento	State Program	Georgia	960	01/31/2010
TestAmerica West Sacramento	State Program	Guam	N/A	08/31/2011
TestAmerica West Sacramento	State Program	Hawaii	N/A	01/31/2012
TestAmerica West Sacramento	State Program	Michigan	9947	01/31/2012
TestAmerica West Sacramento	State Program	Nevada	CA44	07/31/2011
TestAmerica West Sacramento	State Program	New Mexico	N/A	06/30/2011
TestAmerica West Sacramento	State Program	South Carolina	87014	01/31/2012
TestAmerica West Sacramento	State Program	Virginia	178	06/30/2011
TestAmerica West Sacramento	State Program	Washington	C581	05/05/2012
TestAmerica West Sacramento	State Program	Wisconsin	998204680	08/31/2011
TestAmerica West Sacramento	State Program	Wyoming	8TMS-Q	01/31/2012
TestAmerica West Sacramento	US Fish & Wildlife	US Fish & Wildlife	LE148388-0	02/29/2012
TestAmerica West Sacramento	USDA	USDA	P330-09-00055	03/19/2012
TestAmerica West Sacramento	USEPA UCMR	USEPA UCMR	CA00044	10/18/2011
TestAmerica West Sacramento	West Virginia DEP	West Virginia	334	07/31/2012
TestAmerica West Sacramento	West Virginia DHHR (DW)	West Virginia	9930C	12/31/2011

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For more information, or to contact a local TestAmerica representative nearest you, please visit our website at www.testamericainc.com

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The certificates and parameter lists (which may differ) are available, upon request, from a laboratory representative for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Appendix 4: Listing of Methods Performed

Preparation Only Methods

Method	Aqueous	Solid	Waste	Biological	Air
Organics					
Calif. CAM-WET	X	X	X		
EPA 1311	X	X	X		
EPA 3510C	X				
EPA 3520C	X				
EPA 3535	X				
EPA 3540B		X			
EPA 3542					X
EPA 3550B		X		X	
EPA 3580A			X		
EPA 3600C	X	X	X		
EPA 3620B	X	X	X		
EPA 3630C	X	X	X		
EPA 3640A	X	X		X	
EPA 5030B	X	X	X		
EPA 5035	X	X	X		
Inorganics					
Calif. CAM WET	X	X	X		
EPA 1311	X	X	X		
EPA 1312 (W)	X	X	X		
EPA 3005A	X				
EPA 3010A	X				
EPA 3050B		X	X	X	

Organics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Biological	Air
Volatile Organics	SW846 8260B	X	X	X		
Base Neutrals and Acids (BNAs)	SW846 8270B	X	X	X	X	
	TO-13A					X
	IP-7					X
	EPA 23					X
Organochlorine Pesticides	SW846 8081A	X	X	X	X	
	TO-4A					X
	TO-10A					X
	IP-8					X
	WS-ID-0014	X	X	X	X	
	EPA 1669 (Mod)	X	X	X		
PCBs	EPA 8082	X	X	X	X	
	TO-4A					X
	TO-10A					X
Petroleum Hydrocarbons	EPA 8015B	X	X	X		
	CA LUFT	X	X	X		
	AK101	X	X	X		
	Ak102	X	X	X		
	AK103	X	X	X		
	NWTPH-Gx	X	X	X		
	NWTPH-Dx	X	X	X		
	GRO/DRO	X	X	X		
Nitroaromatics and Nitroamines	EPA 8330	X	X	X		X
	EPA 8330A	X	X	X		
	EPA 8330B	X	X	X		
	EPA 8321A (modified)	X	X	X		
	WS-LC-0001	X	X	X		
	WS-LC-0009	X	X	X		
	WS-LC-0010	X	X	X		
Nitrosamines	WS-MS-0012	X	X			
PAHs	EPA 8270C (SIM Isotope dilution)	X	X	X	X	X
	EPA 8270C (SIM)	X	X	X		
	CARB 429	X	X	X	X	X
	TO-13A					X
	IP-7					X
1,4-Dioxane	WS-MS-0010	X				
Alkyl Phenols	WS-MS-0013	X	X		X	
CBSA	WS-LC-0013	X	X			

Parameter	Method	Aqueous	Solid	Waste	Biological	Air
Chemical Warfare Degradates	WS-LC-0004	X	X			
Organosulfur Degradates	EPA 8270C	X	X			
	WS-MS-0003	X	X			
PFOA/PFOS	WS-LC-0020	X	X			
PPCPs (Pharmaceuticals & Personal Care Products)	EPA 1694	X				
Steroids & Hormones	EPA 1698	X				
PCB Congeners	EPA 1668A	X	X	X	X	X
	EPA 1668C	X	X	X	X	X
	CBC1.2	X	X	X		
Dioxins & Furans	EPA 1613B	X	X			
	EPA 8290	X	X	X	X	
	EPA 8290A	X	X	X	X	
	EPA 8280A	X	X	X	X	
	EPA 8280B	X	X	X	X	
	DLFM2.2	X	X	X		
	EPA 0023A					X
	EPA 23					X
	TO-9					X

Metals Methods Performed

Parameter	Methods	Aqueous	Solid	Waste	Biological	Air
Trace Metals	EPA 200.7	X				
	EPA 200.8	X				
	EPA 6010B	X	X	X	X	X
	EPA 6020	X	X	X	X	X
	EPA 0060					X
	EPA 12					X
	CARB 12					X
	EPA 29					X
	CARB 436					X
Hardness	SM 2340B	X				
	EPA 200.7	X				
	EPA 200.8	X				
Mercury	EPA 245.1	X				
	EPA 200.8	X				
	EPA 7470A	X				
	EPA 7471A		X	X	X	X
	EPA 101A					X
	ASTM D6784-02					X
	Ontario-Hydro					X
	EPA 0060					X
	EPA 29					X
	CARB 436					X

Inorganics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Biological	Air
Alkalinity (Carbonate, Bicarbonate, Total)	SM 2320B	X				
Ammonia	EPA 350.1	X				X
Bromide	EPA 300.0	X				
	EPA 9056	X	X			
	EPA 9057					X
	EPA 26A					X
	CARB 421					X
Carbon, Total Inorganic	EPA 9060	X	X			
Carbon, Total Organic	EPA 9060	X	X			
	SM 5310 C	X				
Chloride	EPA 300.0	X				
	EPA 9056	X	X			
	EPA 9057					X
	EPA 26A					X
	CARB 421					X
Chromium, Hexavalent	EPA 7196A	X	X			
	EPA 0061					X
	EPA 306					X
	CARB 426					X
Conductivity	EPA 9050A	X				
	SM 2510 B	X				
Cyanide, Free	EPA 9012A	X	X			
	SM 4500 CN E	X				
Cyanide, Total	EPA 335.4	X				
	EPA 9012A	X	X			
	CARB 426					X
Demand, Chemical Oxygen	EPA 410.4	X				
Flouride	EPA 300.0	X	X			
	EPA 9056	X	X			
	SM 4500 F C	X				
	EPA 9057					X
	EPA 26A					X
	CARB 421					X
n-Hexane Extractable Materials	EPA 1664A	X				
	EPA 9070A	X				
	EPA 9071B		X			
Moisture	ASTM 2216		X			

Nitrate	EPA 353.2	X				
	EPA 300.0	X				
	EPA 9056	X	X			
	CARB 421					X
Nitrate-Nitrite	EPA 353.2	X				
Nitrite	EPA 353.2	X				
	EPA 300.0	X				
	EPA 9056	X	X			
	CARB 421					X
Nitrocellulose	EPA 353.2	X	X			
	WS-WC-0050	X	X			
Total Kjeldahl Nitrogen	EPA 351.2	X				
Orthophosphate	EPA 300.0	X				
	EPA 9056	X	X			
Particulates in Air	EPA 5					X
	40 CFR Part 50					X
Perchlorate	EPA 314.0	X				
	EPA 331.0	X				
	EPA 6850	X	X			
	WS-LC-0012	X	X			
pH	SM 4500 H+ B	X				
	EPA 150.2	X				
	EPA 9040A	X				
	EPA 9041A	X				
	EPA 9045C		X	X		
Phosphorus, Total	EPA 365.4	X				
Solids, Total	SM 2540 B	X				
Solids, Total Dissolved	SM 2540 C	X				
Solids, Total Suspended	SM 2540 D	X				
Sulfate	EPA 300.0	X				
	EPA 9065	X				
Sulfide	SM 4500 S2- D	X				

Appendix 5 . Data Qualifiers

Qualifier Organic	Qualifier Inorganic	Footnote
U	U	Analyte analyzed for but was not detected.
G	G	Elevated reporting limit. The reporting limit is elevated due to matrix interference.
J	B	Estimated result. Result is less than RL.
E	I	Estimated result. Result concentration exceeds the calibration range.
B	J	Method blank contamination. The associated method blank contains the target analyte at a reportable level.
P	*	Relative percent difference (RPD) is outside stated control limits.
a	N	Spiked analyte recovery is outside stated control limits.
*		Surrogate recovery is outside stated control limits.
PG		The percent difference between the original and confirmation analyses is greater than 40%.

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Quality Assurance Manual
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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CW-Q-S-003	Internal Auditing
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
DV-QA-0010	Document Control & Updating Procedures (Sec. 3.4.1)
DV-QA-013P	Customer Complaints (Sec .10.1)
DV-QA-028P	Management of Change(Sec. 3.4.1; 13.2)
DV-QA-0005	Document Archiving Procedure (Sec. 14.1.4)
DV-QA-0024	Training (Sec. 17.3)
DV-QA-001P,	Preparation and Management of Standard Operating Procedures (Sec. 19.2)
DV-QA-0024	Training (Sec. 19.4.2)
DV-QA-005P	Determination of Method Detection Limits (Sec. 19.7)
DV-QA-017P	Electronic Reporting (Sec. 19.14.1)
DV-QA-0023	Subsampling (Sec. 22.5)
DV-QA-0003	Sample Management and Chain of Custody (Sec. 23.2.1.3)
DV-QA-003P	Quality Assurance Program (Sec. 5.5, 23.2.1)
DV-QA-0010	Document Control (Sec. 6.1)
DV-QA-001P	Preparation and Management of Standard Operating Procedures and Other Controlled Documents (Sec. 6.3)
DV-QA-0005	Document Archiving Procedure (Sec. 6.4)
DV-QA-011P	Acceptable Manual Integration Practices (Sec. 19.14.2)
DV-QA-025P	Electronic Data Backup (Sec. 14.1.3)

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SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Denver Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E) In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs

listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *U.S. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 29, 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 2.8, January 2012.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 4. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control procedure (refer to SOP No. DV-QA-0010).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Denver is a local operating unit of TestAmerica Laboratories, Inc.. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Denver is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's Denver laboratory.

4.2.2 Laboratory Director

TestAmerica Denver's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

Specific responsibilities include, but are not limited to:

- Provides one or more technical directors for the appropriate fields of testing. The name(s) of the Technical Director will be included in the national database. If the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Director to temporarily perform this function. If the absence exceeds 65 consecutive calendar days, the primary accrediting authority must be notified in writing. The role of the Technical Director at TestAmerica Denver is fulfilled by the Laboratory Director or appointed designee(s).

- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures TestAmerica's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client specific reporting and quality control requirements are met.
- Captains the management team, consisting of the QA Manager, the Technical Director(s), and the Operations Manager as direct reports.

4.2.3 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

The QA Manager reports directly to the Laboratory Director and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.

- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitor standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025.

4.2.4 Quality Assurance Specialist

The Quality Assurance Specialist performs several roles. The QA Specialist reports to the facility QA Manager. The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitate external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assist the QA Manager in the preparation of new SOP's and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Manages the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Personnel training records review and maintenance.
- Document control maintenance.
- Assists the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Manages certifications and accreditations.
- Monitors for compliance the following QA Metrics: Temperature Monitoring of refrigeration units and incubators; thermometer calibrations; balance calibrations; eppendorf/pipette calibrations; and proper standard/reagent storage.
- Periodic checks on the proper use and review of instrument logs.
- Initiate the Mint-miner data file review process for organic instrumentation. Maintain tracking sheet of activity.
- Initiate the annual Instrument review.
- Assist in the technical review of data packages which require QA review.

4.2.5 Quality Assurance Assistant

The Quality Assurance Assistant performs several roles. The QA Assistant reports to the facility QA Manager. The QA Assistant is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.

- Serves as a project manager for proficiency testing samples and other QC samples. Processes and reports QC samples as routine samples to appropriate agencies.
- Assist the QA Manager in maintaining the laboratory's reference data to keep it current and accurate.
- Prepares certification applications for states as directed by QA Manager.
- Personnel training records review and maintenance.
- Document control maintenance.
- Assisting departments in generating MDL spreadsheets and calculations, reviewing MDL studies submitted to QA.
- Assisting in control limit generation.
- Ensuring maintenance of records archives.
- Maintaining historical indices for all technical records including SOPs, QC records, laboratory data, etc.

4.2.6 Technical Manager or Designee

The Technical Manager(s) report(s) directly to the Operations Manager. He/she is accountable for all analyses and analysts under their experienced supervision and for compliance with the ISO 17025 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercises day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results.
- Coordinating, writing, and reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench. He/she develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design vs. demonstrated versus first-run yield) utilization.
- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.
- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data

quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.

- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc..
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the QA Manager.

4.2.7 Operations Manager

The Operations Manager manages and directs the analytical production sections of the laboratory. He/She reports directly to the Laboratory Director. He/She acts as the Technical Director in determining the most efficient instrument utilization. More specifically, he/she:

- Evaluates the level of internal/external non-conformances for all departments.
- Continuously evaluates production capacity and improves capacity utilization.
- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the Technical Director and QA Manager and in compliance with regulatory requirements.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his substitute in the interim.

4.2.8 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for implementing TestAmerica Denver's radiation safety program. The RSO reports directly to the Technical Director. The RSO's duties consist of:

- Manage the personnel radiation dosimetry program
- Maintains the Radioactive Materials License and radionuclide inventory

- Monitors laboratory operation for compliance with the Radiation Safety Manual
- Training, documenting, and evaluating the TestAmerica Denver personnel for handling radioactive material
- Creating, releasing, and decontaminating of Radiological Control Areas (RCAs)
- Monitoring and tracking of radioactive materials
- Conducting the radioactive material waste disposal program in accordance with State and Federal regulations
- Maintaining all records related to the radiation safety program

4.2.9 Employee Health and Safety Coordinator

The EH&S Coordinator is responsible for administering the EH&S program that provides a safe, healthy working environment for all employees and the environment. The Employee Health and Safety Coordinator (EH&S Coordinator) reports directly to the Laboratory Director and the corporate Environmental Health and Safety Director. He/She monitors all areas for unsafe conditions, acts, and potential hazards. Specific responsibilities include, but are not limited to:

- Staying current with the hazardous waste regulations
- Continuing training on hazardous waste issues
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual.
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste
- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.
- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.

- Determine when a complaint of possible over-exposure is "reasonable" and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica's medical consultants.

4.2.10 Hazardous Waste Specialist

The Hazardous Waste Specialist is responsible for coordinating and implementing the divisional hazardous waste program to ensure compliance with all federal, state, local laws, and company policies. The Hazardous waste specialist reports to the EH&S Coordinator. The duties consist of:

- Staying current with the hazardous waste regulations
- Conducts weekly inspections of satellite accumulation areas and all hazardous waste storage areas
- Operates and maintains on-site wastewater treatment system
- Coordinates the proper storage, packing and disposal of laboratory wastes according to Department of Transportation (DOT) and Resource Conservation and Recovery Act (RCRA) regulations
- Maintains waste disposal records
- Coordinates spill response activities including documentation for waste storage areas

4.2.11 Waste Disposal Technician

The Waste Disposal Technician is responsible for proper disposal of spent chemicals, process waste, and unused laboratory samples used in the laboratory according to corporate, federal, state, and local guidelines. The Waste Disposal Technician reports to the Hazardous Waste Specialist and EH&S Coordinator. The duties consist of:

- Packaging hazardous waste for transport per DOT, RCRA and TSCA guidelines
- Identifying waste streams and maintaining satellite accumulation areas
- Packages expired chemicals for shipment or disposal
- Tracks volume of waste generated for reporting to corporate and EPA
- Prepares and tracks implementation of the Waste Minimization Plan
- Empties satellite containers into bulk containers and returns to the laboratory for reuse

4.2.12 Department Manager

Department Managers report to the Operations Manager. At TestAmerica Denver there are two levels of Department Managers (I or II). The level designation is based on the level of experience. Each one is responsible to:

- Ensure that analysts in their department adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in

compliance and if new, modified, and optimized measures are feasible and should be added to these documents.

- With regard to analysts, participates in the selection, training, development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts and documents these activities in accordance with systems developed by the QA and Personnel Departments. They evaluate staffing sufficiency and overtime needs. Training consists of familiarization with SOP, QC, Safety, and computer systems.
- Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervise, and function as a department team.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Director, Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, non-conformance and CPAR issues, the timely and accurate completion of performance evaluation samples and MDLs, for his department.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager, Technical Director, Operations Manager, and/or Laboratory Director.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He/She is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.
- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieve optimum turnaround time on analyses and compliance with holding times.
- Conduct efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs. demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.
- Develop, implement, and enhance calibration programs.
- Provide written responses to external and internal audit issues.

4.2.13 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The Analyst position at TestAmerica Denver is divided into levels. These levels range from Analyst I to Analyst V. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database
- Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Director, and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated prior to entering and submitting for secondary level review.
- Suggest method improvements to their supervisor, the Technical Director, and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.14 Laboratory Technician

Laboratory Technicians are responsible for the preparation of samples and performing all tasks assigned to them by the group leader or supervisor. The Laboratory Technician position at TestAmerica Denver is divided into three levels. These levels are Laboratory Technician I, Laboratory Technician II, and Laboratory Technician III. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the Laboratory Technician are listed below:

- Retrieving samples from Sample Control for analysis
- Performing sample preparation by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Documenting standard and sample preparation, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database
- Report all non-conformance situations, sample preparation problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Director, and/or the QA Manager or member of QA staff.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.15 Laboratory Assistant

The Laboratory Assistant position is an entry-level position to learn basic laboratory technician skills. The Laboratory Assistant reports to their group leader or supervisor. The Laboratory Assistants duties include the following:

- Assisting the Laboratory Technicians in preparation of samples for analysis
- Preparing routine forms and reports
- Collecting and preparing materials and supplies for the laboratory
- Assisting technicians in conducting routine analysis.

4.2.16 Sample Control Manager

The Sample Control Manager reports to the Project Management Manager. The responsibilities are outlined below:

- Direct the logging of incoming samples into the LIMS
- Ensure the verification of data entry from login
- Provide daily assessments of sample receipts
- Monitor the preparation and shipment of bottle kits to clients
- Oversee the receipt, log in, and storage of samples
- Schedules couriers for sample pickup from customer sites

4.2.17 Sample Control Technician

The Sample Control Technician reports to the Sample Control Manager. The Sample Control Technician position at TestAmerica Denver is divided into levels. These levels range from Sample Control Technician I to Sample Control Technician IV. The level designation is based on experience and responsibilities of the Technician. The Sample Control Technician responsibilities include the following:

- Receive and unload samples or consignments in accordance with DOT regulations
- Verify samples against the Chain of Custody (COC)
- Log in sample into the LIMS to assign a lot number for tracking purposes and distribute the paperwork to the Project Managers and Department Managers
- Label samples with lot number assigned and deliver the samples to the appropriate labs for analysis daily
- Monitor freezer and cooler temperatures daily to confirm that the readings are within SOP guidelines
- Ship all subcontracted samples to designated lab in accordance with DOT regulations as needed

4.2.18 Shipping/Maintenance Technician

The Shipping/Maintenance Technician reports to the Sample Control Manager and the Project Management Manager. The Shipping/Maintenance Technician duties include the following:

- Maintaining the inventory control system
- Receiving and distributing incoming supplies
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Maintaining bottle and cooler inventory
- Packing in-house samples for shipment to other laboratories

4.2.19 Courier

The Courier reports to the Sample Control Manager and the Project Management Manager. The Courier's duties include the following:

- Picking up and delivering samples and reports to clients and the laboratory
- Receiving and signing the chain of custody for samples
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Performing preventative maintenance on company vehicles

4.2.20 Project Management Manager

The Project Management Manager reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team
- Technical liaison for the Project Management team
- Human resource management of the Project Management team
- Responsible to ensure that clients receive the proper sampling supplies
- Accountable for response to client inquiries concerning sample status
- Responsible for assistance to clients regarding the resolution of problems concerning COC
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory
- Notifying the supervisors of incoming projects and sample delivery schedules
- Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates
- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff

- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports
- Inform clients of data package-related problems and resolve service issues
- Coordinate requests for sample containers and other services (data packages)

4.2.21 Project Manager

The Project Managers report to the Project Management Manager and serve as liaisons between the laboratory and its clients. At TestAmerica Denver there are two levels of Project Managers (I or II). The level designation is based on experience, expertise, and responsibilities. The Project Manager's responsibilities include:

- Ensuring client specifications are met by communicating project and quality assurance requirements to the laboratory
- Notifying laboratory personnel of incoming projects and sample delivery schedules
- Monitoring the status of all projects in-house to ensure timely delivery of reports
- Informing clients of project-related problems, resolving service issues and coordinating technical issues with the laboratory staff
- Coordinating client requests for sample containers and other services
- Scheduling sample pick-ups from client offices or project sites and notifying the laboratory staff of incoming samples.
- Coordinating subcontract work
- Assisting clients in procuring the proper sampling supplies
- Responding to client inquiries concerning sample status
- Assisting clients with resolution of problems concerning Chains-of-Custody

4.2.22 Project Management Assistant

The Project Management Assistant reports to the Project Management Manager and designated Project Manager. The Project Management Assistant assists the Project Manager in servicing the client's needs and communicating those needs to the laboratory. The Project Management Assistant's responsibilities include:

- Collating data reports, expanded deliverables, CLP data packages and electronic data deliverables (EDD's) for delivery to clients.
- Writing case narratives accompanying data packages to communicate anomalies to clients
- Entering data from subcontracted laboratories
- Proof reading and filing data reports received from the laboratory

- Assisting Project Managers in changing compound lists, TAT, and setting up tables in Word or Excel
- Monitoring report due dates for timely delivery
- Invoicing completed data packages
- Generating credit or debit invoices to ensure proper payment
- Copying and paginating reports

4.3 DEPUTIES

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Robert C. Hanisch Laboratory Director	Brett VanDelinder Customer Service Manager
John Morris Quality Manager	Peggy Sleevi Quality Assurance Specialist
Adam Alban EHS Coordinator	Chad Lancaster Waste Control Specialist
Brett VanDelinder Customer Service Manager	Pat McEntee Program Support Manager
Karen Kuoppala Operations Manager	William Rhodes VOA GC/MS Manager

Figure 4-1. Corporate and Laboratory Organization Charts

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Executive Committee

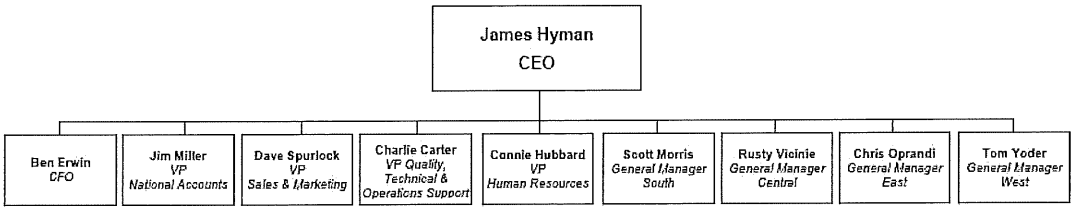

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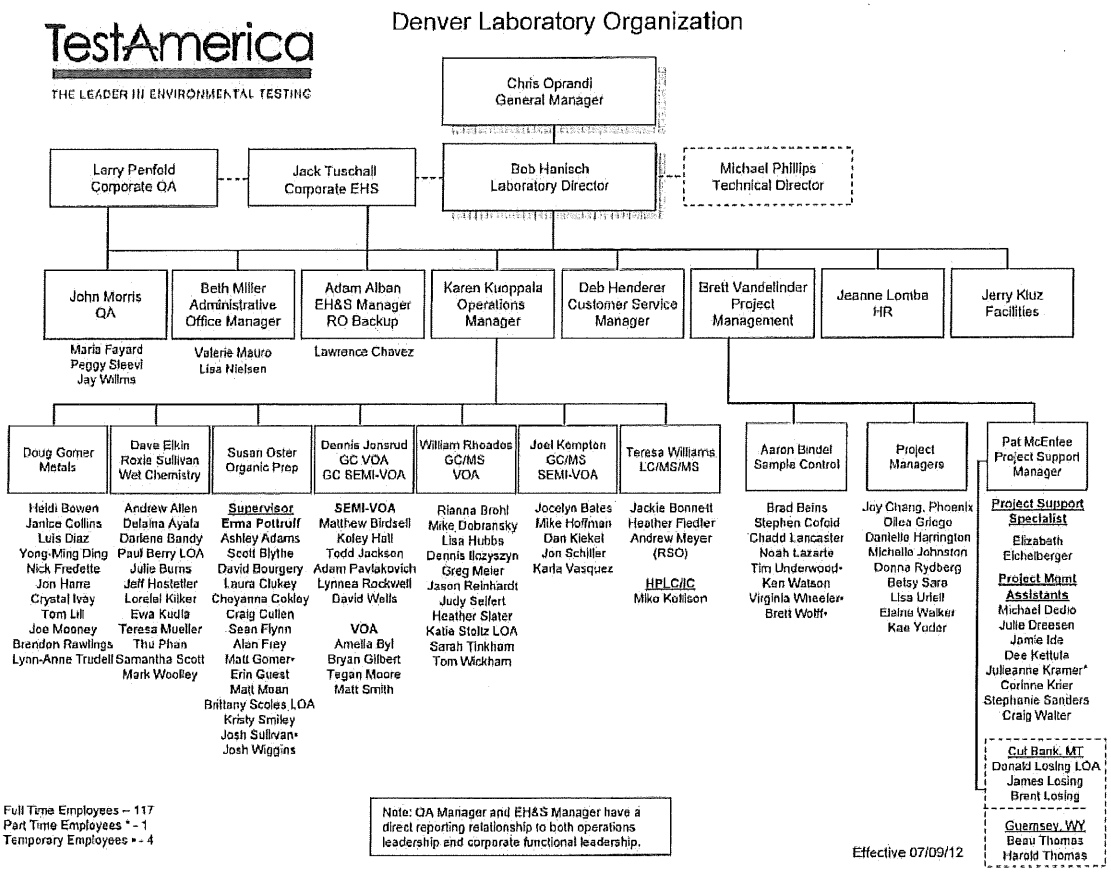
Figure 4-1. Corporate and Laboratory Organization Charts – con't



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.
- Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002.)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).

- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit). Other terms may be used to reflect the method detection limit or reporting limit for specific programs.

5.5 Criteria for Quality Indicators

The laboratory maintains a *Quality Control Limit Summary* in the LIMS referred *to as "Method Limit Groups"* that summarize the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in SOP DV-QA-003P, *Quality Assurance Program.*

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The control charting process is defined in detail in SOP DV-QA-003P. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Technical Manager and QA Manager) and entered into the Laboratory Information Management System (LIMS). The LIMS maintains an archive of all limits used within the laboratory. Limits are entered into the Method Limit Groups according to the effective date. All historical limits can be pulled using the "Historical" feature in the LIMS. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

As the QC limits are calculated, QC charts are generated showing warning and control limits for the purpose of evaluating trends. Refer to SOP DV-QA-003P for a description of the control charting process and evaluation of trending.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory specific SOP DV-QA-0010, *Document Control* provides additional information for the Denver laboratory procedures.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of

document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a department manager submits an electronic or hardcopy draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP No. DV-QA-001P, *Preparation and Management of Standard Operating Procedures (SOPs) and Other Controlled Documents*. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the Public server in the QA folder G:\QA\READ\SOPS\ESOPS\ALL.

For changes to SOPs, refer to SOP No. DV-QA-001P, *Preparation and Management of Standard Operating Procedures (SOPs) and Other Controlled Documents.* The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions, white papers, protocols, and information are organized by department and document type in the QA office. Electronic versions are kept on the Public server in the QA folder under G:\QA\Edit\FORMS and G:\QA\READ\SOPS\Word Docs. The procedure for the care of these documents is in SOP DV-QA-001P.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP DV-QA-0005, *Document Archiving Procedure.*

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Customer Service Manager (CSM) is considered adequate. The CSM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the National Account Director, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in SOP No. CA-L-P-002, Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- The Laboratory Project Manager
- Customer Service Representative
- The Laboratory Operations Manager
- Laboratory and/or Corporate Technical Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Regional and/or National Account representatives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts. TestAmerica Denver's Customer Service Department maintains copies of all signed contracts for reference locally.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Contracts filed by the CSM group are filed in locked fire proof cabinets.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Regional Account Manager. A copy of the contract and formal quote will be filed with the laboratory CSM and the Lab Director/Manager.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing. Unique or large programs generally have a Quality Assurance Summary prepared by the PM. This summary is posted on the public Outlook folders for anyone in the lab to access. The Quality Assurance Summary documents all requirements that are non-standard.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated in the Quality Assurance Summery and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Technical Directors and/or Quality Assurance are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required. Refer to SOP DV-QA-0027 for laboratory specific procedures.

Project Managers (PMs), Customer Service Managers (CSM), or Regional Account Executives (RAE) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g, USDA) or contracts (e.g, certain USACE projects)-may require notification prior to placing such work (see SOP DV-QA-0027 for laboratory specific procedures).

8.2 Qualifying and Monitoring Subcontracators

Whenever a PM or Customer Service Manager (CSM) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, Account Executives, CSMs, or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the

use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM or CSM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM (or RAE or CSM, etc.) responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented on a Subcontracted Sample Form (Figure 8-1) and the form is retained in the project folder. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples workshared within TestAmerica. Client CoCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client CoCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.

Example: Verification of Subcontract Lab Status Form

TestAmerica Denver is responsible to our clients for on-going assurance that subcontracted analytical services meet TestAmerica Denver's expectations for quality. As part of this program, we require on-going verification that the following statements are true. Please return the completed form with the final report to TestAmerica Denver.

Laboratory Name: _____

	True	False	N/A	Comments
Your laboratory continues to hold current certifications as applicable to the requested fields of testing?				
Your laboratory has successfully completed PT samples for at least 2 of the last 3 of the requested fields of testing?				
Your laboratory has successfully completed method detection limits for the requested fields of testing within the last 12 months?				
There are no changes in equipment that affect the laboratory's capability to perform the requested fields of testing?				
There are no changes in qualified personnel that affect the laboratory's capability to perform the requested fields of testing?				
All testing is performed at the location to which the samples were delivered?				
Your laboratory does not have any OSHA, DOT, DoE, DoD, or EPA citations or pending investigations?				

Completed by: _____ on _____.
Name

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst completes the Material Request Sheet when requesting reagents, standards, or supplies. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

The analyst must provide the master item number (from the master item list that has been approved by the Technical Director), item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the Technical Director prior to placing the order. The purchasing manager or designee places the order.

9.3.2 Receiving

It is the responsibility of the shipping/receiving technician to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials where received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date cannot be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded, the dry chemical/solvent must be discarded.
- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained within each department.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 500 psig or the tank must be replaced. To prevent a tank from going to dryness, close observation of the tank gauge must take place as pressure decreases towards 500 psig, or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in the LIMS. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Director or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Manager/Director, Operations Manager, and/or the Laboratory Director. If they agree with the

request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and the corporate office places the actual order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Technical Managers. The service providers that perform the services are approved by the Technical Manager / Director.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technology Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following in SOP DV-QA-013P, *Customer Complaints.*

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOP # DV-QA-013P.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or

making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. Refer to SOP# DV-QA-0031, *Nonconformance and Corrective Action System* for the procedure to handle such situations.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Director and QA Manager, documented and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, a Technical Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

11.4 Prevention of NonConforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. On a monthly basis the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc.). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Operations Manager, Technical Manager/Director, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCM) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.

- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Report (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCMs.
- Issues found while reviewing NCMs that warrant further investigation.
- Internal and external audit findings
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Client complaints
- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports
- Health and Safety violations

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the

event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.

- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technical Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.

- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with

an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original "uncorrected" file must be maintained intact and a second "corrected" file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report

TestAmerica Corrective Action Plan

TAL Audit # *Program:* *Requirements Document:*

Purpose: Not entered *Company Auditing:*

Date Audited: *Lead Auditor:*

Date Report Received: *Response Due Date:*

TAL Issue Number *Status:* *Title:*

Reference Citation: *Lab Process:* *Lab Section:*

Client Issue #: *Type of Issue:* *Method #:*

Finding Description:

Cause Analysis:

Corrective Action Plan:

Lab Responsible Party:

Planned Completion Date:

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Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank *(Analyst)*	- Instrument response < ½ RL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards *(Analyst, Technical Manager(s))*	- Correlation coefficient > 0.99. - Standard concentrations should bracket reporting limit. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Technical Manager(s))*	- % Recovery within control limits as defined in the method SOPs.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in LIMS.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. See SOP DV-QA-003P for detailed corrective actions.
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in LIMS.	See SOP DV-QA-003P for detailed corrective actions.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean.	See SOP DV-QA-003P for detailed corrective actions.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1]	See SOP DV-QA-003P for detailed corrective actions.
Proficiency Testing (PT) Samples *(QA Manager, Technical Manager(s))*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Internal / External Audits *(QA Manager, Technical Manager(s), Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 and DV-QA-019P.
Client Complaints *(Project Managers, Lab Director/Manager, Sales and Marketing)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated). See SOP DV-QA-013P.
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director/Manager, *Technical Manager(s)*)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director/Manager, *Technical Manager(s)*)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

Note:
1. Except as noted below for certain compounds, the method blank should be below ½ the reporting limit. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: Facility Changes, Major Accreditation Changes, Addition or Deletion to Division's Capabilities or Instrumentation, Key Personnel Changes, Laboratory Information Management System (LIMS) changes. This process is discussed in further detail in SOP # DV-QA-028P, *Management of Change.*

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA department in a database, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic

or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Department Manager or their designee.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained indefinitely)
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.

[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or the Iron Mountain data storage facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Records are maintained on-site at the laboratory for at least 3 months after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have longer retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
DOE	Indefinite
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information. In addition, refer to SOP # DV-QA-025P, *Electronic Data Backup.*

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this

package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set per SOP #DV-QA-0005, *Document Archiving Procedure*. Instrument data are stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data are lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP #DV-QA-0005, *Document Archiving Procedure.*

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'.

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code;
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a benchsheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- test results;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);

- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

The laboratory has a record management system (a.k.a., document control) for control of

laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data. Records are considered archived when noted as such in the records management system (a.k.a., document control.)

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing internal auditing, SOP No. CW-Q-S-003. The types and frequency of routine internal

audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	Methods Audits Frequency: 50% of methods annually 100% of methods annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner and Chrom AuditMiner) used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Drinking Water (WS), Nonpotable Water (WP), Soil, Underground Storage Tank (UST).

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Technical Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Technical Managers, their Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of

policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Managers, QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel are to be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 & Work Instruction No. CA-Q-WI-020) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed).
- Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in a finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's VP of Client & Technical Services, General Managers and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular

area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience

Specialty	Education	Experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Technical Managers– **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience
Technical Managers - Microbiology	Bachelors degree in applied science with at least 16 semester hours in general microbiology and biology An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years of relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in the training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics is maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP DV-QA-0024.

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004 and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 54,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas.
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to the following documents and procedures for specific requirements for microbiological laboratory facility requirements.

- Standard Methods, 20th Ed., 9020B, Sec. 2
- TNI V1M5, 1.7.3.7.a

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002 or the laboratory's SOP DV-QA-001P.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*

- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC, DV-QA-0024) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Director and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 Refer to SOP DV-QA-0024, Training.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1 as an example shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the

precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities are required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method. For example for GC methods a confirmation analysis must be performed using a different column. This would not be necessary for mass spectrometry methods.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded.

The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data are to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria. An example of this would be to run various spike levels across the calibration range to verify acceptable accuracy and precision.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted

by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL.

Refer to the Corporate SOP No. CA-Q-S-006 or the laboratory's SOP No. DV-QA-005P Determination of Method Detection Limits, for details on the laboratory's MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3x the absolute value of the standard deviation.

If the IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. Refer to the laboratory SOP DV-QA-005P, *Determination of Method Detection Limits* for further details.

The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not

consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand". (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/L, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/L, which could also be written as 1.0 +/- 0.5 mg/L.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats.

Note: Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within $\pm$ 1 reporting limit for samples $\leq$ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Supervisor or Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP DV-QA-017P, *Electronic Reporting*. The laboratory is currently running the TestAmerica Laboratory Information Management System which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Sequel Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 Maintain the Database Integrity: Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 Ensure Information Availability: Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 Maintain Confidentiality: Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The data review checklists, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices*. and TestAmerica Denver SOP DV-QA-011P, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the batch folder and batch file in LIMS. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/L, results can be reported in percent, i.e., 10,000 mg/L = 1%. Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report. Refer to DV-QA-004P, *Rounding and Significant Figures* for details regarding the number of significant figures to report for each step in the process.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. When this is not possible the data is entered into a logbook which becomes part of the raw data. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-

matched compounds. The analyst reviews the values in LIMS against the raw results to check for errors. The instrument's calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the batch file in LIMS. In addition, the data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the Technical Director/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are out lined in several SOPs (e.g. DV-QA-0003, *Sample Management and Chain of Custody*, DV-QA-0020, *Data Review*, and DV-QA-0022, *Data Package Assembly),* to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data DV-QA-011P, *Acceptable Manual Integration Practices*. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into a computer LIMS. The Sample Control Supervisor reviews the transaction of the chain-of-custody forms and the inputted information. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately

15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Director/Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.4.7 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an

invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for our internal SOP No. DV-QA-011P, entitled *Acceptable Manual Integration Practices.*

19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Analyst
July 16, 2010

DV-OP-0016
Ultrasonic Extraction of Solid Samples
Method SW846 3550B and 3550C

We the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the TestAmerica Quality Assurance Manual, has met the Initial or Ongoing Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification following the TestAmerica SOP and source method.
3. A copy of the laboratory-specific SOP and source method is available for all personnel on-site. These documents have been reviewed by the analyst as part of this Demonstration of Capability.
4. The data associated with the initial/ongoing demonstration of capability are true, accurate, complete and self-explanatory (*). These data are attached to this certification statement.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

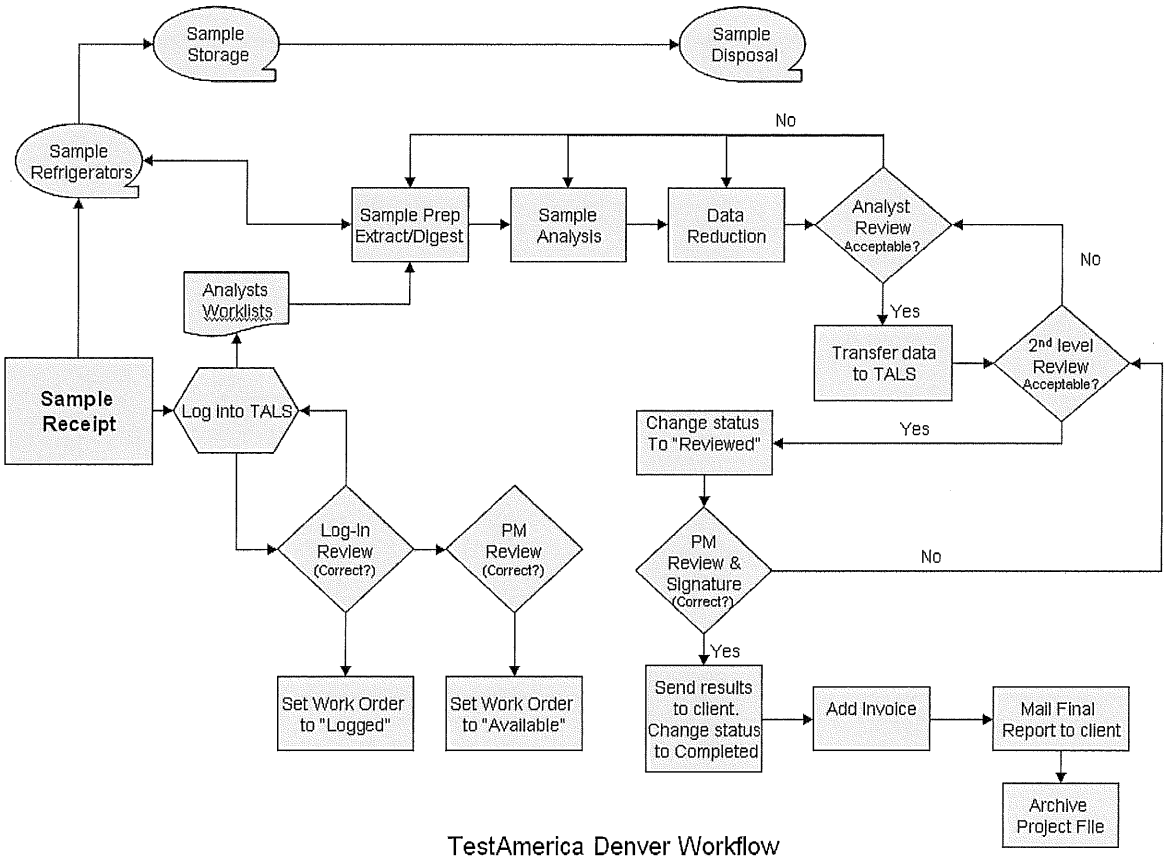
Comments/Observations:

Analyst's Name Signature & Date

Technical Director's Name Signature & Date

QA Manager's Name Signature & Date

Figure 19-2. Example: Work Flow



TestAmerica Denver Workflow

SECTION 20. EQUIPMENT AND CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Technical Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be/are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or

maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually

and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to SOP DV-QA-0014, *Balance Calibration Check*.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly.

The mercury NIST thermometer is recalibrated every five (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in SOP DV-QA-0001, *Thermometer Calibration Procedure*.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored 7 days a week.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0°C and ≤ 6 °C.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logbooks and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label is / can be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements. Refer to an SOP DV-QA-0008, *Calibration and Verification of Mechanical Pipettes.*

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. Syringes are verified for syringe sizes of ≥ 100 µL are verified. Details are in DV-QA-0008.

20.3.6 Autoclaves

TestAmerica Denver uses an autoclave for sterilization of microbiological equipment and used media only. All information regarding the autoclave is maintained in the Autoclave, Coliform lot, and Monthly check logbook. The information recorded includes the date, contents, maximum temperature, total run time and the analyst's initials.

Demonstration of sterilization of the autoclave is performed each time of use with a Diack sterilization monitor, a maximum reading thermometer, and temperature sensitive tape. On a monthly basis, spore strips are used for the determination of effective sterilization.

The autoclaves timing device is checked on a monthly basis against a clock/watch and the actual time elapsed is documented.

Any maintenance that is performed on the autoclave (internally or by service contract) is recorded in the maintenance section of the check logbook.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (e.g., GC/MS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument/method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable under the following special conditions:

a) When the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b) When the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the two conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be

reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GC/MS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Example: Instrumentation List

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
ICP	Thermo Fischer (025)	ICP 6500 S/N 20090307	2006	6010, 200.7
ICP	Thermo Fischer (026)	ICP 6500 S/N 20063207	2006	6010, 200.7
ICP/MS	Agilent ICP-MS (024)	7500 Series S/N JP51201530	2006	6020, 200.8
ICP/MS	Agilent ICP-MS (077)	7700 Series S/N JP09320047	2009	6020, 200.8
Mercury Analyzer	Cetac CVAA (033)	M-7500 S/N 08092QTA	2010	7470, 7471, 245.1
Mercury Analyzer	Cetac CVAA (034)	M-7500 S/N 0021105QTA	2011	7470, 7471, 245.1
Ion Chromatograph	Dionex (IC3)	DX-120 S/N 98040510	1997	300.0, 9056 9056A
Ion Chromatograph	Dionex (IC4)	AS 50 S/N 056537	2000	Hydrazine, MMH, UDMH
Ion Chromatograph	Dionex (IC5)	LC 20 S/N 0106180	2002	314.0
Ion Chromatograph	Dionex (IC6)	ICS 2000 S/N 03100162/03100118	2003	300.0, 9056 9056A
Ion Chromatograph	Dionex (IC7)	ICS 2000 S/N 03100161/03100122	2003	300.0, 9056 9056A
Ion Chromatograph	Dionex (IC8)	ICS 2000 RFIC S/N 08020954/08020762	2008	300.0, 9056 9056A
Ion Chromatograph	Dionex (IC9)	ICS 3000 S/N 08020888	2008	Hydrazine, MMH, UDMH
TOC	LECO (LEC)	C632 (Solid) S/N 3097	2007	9060, 5310B
TOC	Shimadzu (SHI3)	TOC-VCPN S/N H51404335027	2005	415.1, 9060, 5310B
TOC	Shimadzu (SHI2)	TOC-VCSH S/N 414445340	2008	415.1, 9060, 5310B
TOX	Thermo Euroglass (Thermo 3)	ECS 1200 S/N 993752/ 2008.283	2008	9020, 9021, 9023
TOX	Thermo Scientific (Thermo 2)	ECS 1200 S/N 993728/ 2004.119	2004	9020, 9021, 9023
UV/VIS	Alpkem (Alp1)	A002393 S/N 908893427/ 906850834	1997	325.2, CN, Phenol
UV/VIS	Alpkem (Alp2)	A002393 S/N 917893398/ 912850458	1997	350.1, 353.2
UV/VIS	Alpkem (ALP3)	Flow Solution 3000 S/N 632-1010-49/60092	2010	350.1
UV/VIS	Konelab	Model 20 S/N P0518697	2003	365.1, 420.1
UV/VIS	Astoria Pacific Analyzer	Astoria 2 S/N 200052	2005	351.2, 353.2, 365.1, 365.1 LL

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT2)	PC – Titrate PC-1000	2000	9040, 9045, 2320B, 2510B, 9050A
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT3)	PC – Titrate PC-1000	2011	9040, 9045, 2320B, 2510B, 9050A
pH Meter	ThermoScientific	Orion 5 Star S/N: B27854	2012	9040, 9045, 4500-H B
pH Meter	ThermoScientific	Orion 3 Star S/N: B15566	2009	2320B, 2310B
Conductivity Meter	YSI	YSI 3200-115V S/N: 02G0765 AF	2009	Not in use
Conductivity Meter	Orion	Orion 160 S/N: 42536014	1985	2510B, 9050A
Dissolved Oxygen Meter	YSI	5100 S/N 08D100984	2008	Not in use
Dissolved Oxygen Meter	YSI	5100 S/N 02G0238	2008	405.1, 5210B
Turbidimeter	HF Scientific (TB2)	Micro 100	2001	180.1
Flashpoint	Herzog Pensky Martens	Model MP-329 S/N 043291648	2003	1010, 1010A
Spectrophotometer	HACH	DR/2010 S/N 990200012321	2007	410.4, 7196A, 3500 Fe D, 3500 Cr B, 3500 Cr D, 4500S-2 D, 420.1
Spectrophotometer	Genysys	Genysys 20 SN: 3SGP171002	2011	410.4, 7196A, 3500 Fe D, 3500 Cr B, 3500 Cr D, $4500S^{-2}$ D, 420.1
GC/MS Semivolatiles	Hewlett-Packard (B)	6890 – GC S/N US00007283 5973 – MSD S/N US70820578	1999	8270, 625
GC/MS Semivolatiles	Hewlett-Packard (D)	6890 – GC S/N US00007319 5973 – MSD S/N US70820578	1996	8270, 625
GC/MS Semivolatiles	Agilent Technologies (F)	6890 – GC S/N US00036181 5973N – MSD S/N US02480180	1996	8270 SIM
GC/MS Semivolatiles	Agilent Technologies (K)	6890N – GC S/N CN10332028 5973 – MSD S/N US33266011	2003	8270, 8270 SIM, 625

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
GC/MS Semivolatiles	Agilent Technologies (GCMS6)	7890A – GC S/N CN10933128 5975C inert XL w/ triple Axis Detector S/N US92033627	2010	8270
GC/MS Semivolatiles	Agilent Technologies (G4)	6890N – GC S/N CN10438087 5973 Inert – MSD S/N US43120937	2004	8270 Best Practice
GC/MS Semivolatiles	Agilent Technologies (X4)	6890N – GC S/N CN10438076 5973 inert – MSD S/N US43120927	2004	8270, 625
GC/MS Semivolatiles	Hewlett-Packard (Y)	6890 – GC S/N US00007291 5973 – MSD S/N US70820572	1996	8270, 625
GC/MS Semivolatiles	Agilent Technologies (G5)	6890N – GC S/N CN10605078 5975 – MSD S/N US60532282	2006	8270, 8270 SIM, 625
GC/MS Volatiles	Agilent Technologies (C) O·I Analytical	6890N – GC S/N US00007315 5973 – MSD S/N US70820571 4552 - Purge & Trap S/N 14049 4660 Concentrator S/N A344466379E	2002	8260
GC/MS Volatiles	Agilent Technologies (E) O·I Analytical	6890 – GC S/N-US00029543 5973 – MSD S/N –US93122910 4552 - Purge & Trap S/N - 13442 4660 – Concentrator S/N – G116466985P	2011	8260
GC/MS Volatiles	Hewlett-Packard (H) O·I Analytical	5890II – GC S/N 3336A60700 5972 – MSD S/N 3524A03013 4552 – Purge & Trap S/N 14052 4660 – Concentrator S/N A3444663771	1994	8260-Water
GC/MS Volatiles	Hewlett Packard (P) O·I Analytical	6890 - GC S/N US00007321 5973 – MSD S/N US70820566 4552 – Purge & Trap S/N 14377 4660 - Concentrator S/N C509466078P	1997	8260, 624

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
GC/MS Volatiles	Hewlett-Packard (G) Varian OI Analytical	5890 Series II - GC S/N 3336A56276 5972 – MSD S/N 3435A01850 Archon Purge & Trap S/N 12751 O·I 4560 - Concentrator S/N	1996	8260
GC/MS Volatiles	Hewlett-Packard (J) Varian OI Analytical	5890II – GC S/N 3336A60701 5972 – MSD S/N 3524A03016 Archon Purge & Trap S/N 12726 O·I 4560 – Concentrator S/N D308367	1994	8260
GC/MS Volatiles	Agilent Technologies (R1) O·I Analytical	6890N - GC S/N LN10524033 5973 Inert – MSD S/N US52420237 4552 – Purge & Trap S/N 14043 4660 – Concentrator S/N A344466372B	1994	8260, 624
GC/MS Volatiles	Hewlett-Packard (R2) O·I Analytical	5890II - GC S/N 336A53965 5972 – MSD S/N 3501A02273 4552 – Purge & Trap S/N 14052 4660 – Concentrator S/N C509466077E	1995	8260, 624
GC/MS Volatiles	Hewlett-Packard (Z) O·I Analytical	5890II – GC S/N 3336A60013 5972 – MSD S/N 352AA02693 Archon Purge & Trap S/N C429411174 O·I 4660 –Concentrator S/N G109466777	1996	8260
GC/MS Volatiles	Agilent Technologies (GCMS1) O·I Analytical	6890N – GC S/N CN10420009 5973 – MSD S/N US35120257 4552 – Purge & Trap S/N 14593 4660 – Concentrator S/N C509466077P	2004	8260, 624

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
GC/MS Volatiles	Agilent Technologies (G2) Varian	6890N – GC S/N CN10421078 5973 – MSD S/N GS36120303 Archon Purge & Trap S/N MS0902W012 O·I 4660 – Concentrator S/N 19374669269	2004	8260
GC/MS Volatiles	Hewlett-Packard (Q) Varian OI Analytical	6890 – GC S/N US0000021949 5973 – MSD S/N US72810801 Archon Purge & Trap S/N 12750 O·I 4560 – Concentrator S/N 308366	2001	8260
GC/MS Volatiles	Agilent Technologies (GCMS7) OI Analytical	6890N – GC S/N US10229109 5975B – MSD S/N US60522608 Archon 4552 S/N 14212 Eclipse 4660 B428466805P	2012	8260, 624
GC/MS Volatiles	Hewlett-Packard (I) Tekmar Dohrmann	5890 – GC S/N 2643A11361 7000 – Headspace Autosampler S/N US03038002	2003	Volatile Screening
GC/MS Volatiles	Hewlett-Packard (T) Tekmar Dohrmann	5890 Series II – GC S/N 2750A14928 7000HT Headspace Autosampler S/N US01198005	2001	Volatile Screening
GC Semivolatiles	Hewlett-Packard (A)	5890 Dual FID S/N 2750A16891	1987	8015 Alcohol
GC Semivolatiles	Hewlett-Packard (C)	6890 Dual ECD S/N US00029514	1999	608, 8081
GC Semivolatiles	Hewlett-Packard (D)	6890 Dual NPD S/N DE00020818	1997	614, 8141
GC Semivolatiles	Agilent Technologies (D2)	6890N Dual NPD S/N US10521035	2004	614, 8141
GC Semivolatiles	Hewlett-Packard (E)	5890II Dual ECD S/N 3121A35858	1992	504.1, 8011
GC Semivolatiles	Hewlett-Packard (M)	6890 Dual ECD S/N US00024143	1999	615, 8151
GC Semivolatiles	Agilent Technologies (P1)	6890N Dual ECD S/N US10418019	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P2)	6890N Dual ECD S/N US10418024	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P3)	6890N Dual ECD S/N US10418023	2004	608, 8082
GC Semivolatiles	Hewlett-Packard (R)	5890II Dual ECD S/N 3336A55030	1994	Not in use

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
GC Semivolatiles	Hewlett-Packard (U)	5890II Single FID S/N US00063217	1999	8015 DRO
GC Semivolatiles	Agilent (U2)	7890A Dual FID S/N CN10942072	11/11/09	8015 DRO
GC Semivolatiles	Hewlett-Packard (V)	5890 Dual ECD S/N 2631A08686	1990	615, 8151
GC Semivolatiles	Hewlett-Packard (W)	5890II Dual ECD S/N 3126A36250	1990	608, 8082
GC Semivolatiles	Hewlett-Packard (Z2)	5890II Dual FID S/N 3336A51924	1990	Glycols
GC Volatiles	Hewlett-Packard (B) Tekmar	5890 Series II Dual PID/FID S/N 3019A28634 LSC 2000 Concentrator S/N 90142014 ALS 2016 Purge & Trap S/N 89108007	1990	8021 GRO
GC Volatiles	Hewlett-Packard (J) Tekmar Dohrmann	6890 Dual FID S/N US00026194 HS Autosampler 7000 HT S/N US02296004	1997	RSK-175
GC Volatiles	Hewlett-Packard (K) Tekmar	5890A Dual PID Single FID S/N 2843A19497 LSC 2000 Concentrator S/N 92098003 ALS 2016 Purge & Trap S/N 92101007	1988	8015, 8021 Aromatics, 8021 GRO
GC Volatiles	Hewlett-Packard (L) Tekmar	5890A FID S/N 2336A00164 LSC 2000 Concentrator S/N 89283001 ALS 2016 Purge & Trap S/N 90121028 ALS 2032 Purge & Trap S/N 94300004	1988	8015 GRO
GC Volatiles	Hewlett-Packard (P) Tekmar	5890A Dual PID Single FID S/N 2518A05337 LSC 2000 Concentrator S/N 89310005 ALS 2016 Purge & Trap S/N 90100036	1990	8021
GC Volatiles	Agilent Technologies (S-1) O I Analytical	6890 Dual PID/ Dual ELCD S/N US10341120 4552 – Purge & Trap S/N 14046 4660 – Concentrator S/N 343466333P	2003	8021
GC Volatiles	Hewlett-Packard (Y) Tekmar	5890A PID/FID S/N 2843A19484 LSC 3000 Concentrator S/N 93132006 ALS 2016 Purge & Trap S/N 91112002 ALS 2032 Purge & Trap S/N 88145006	1988	Screening

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
GC Volatiles	Hewlett-Packard (H) Tekmar	5890A Dual PID Single FID S/N 2750A16573 LSC 2000 Concentrator S/N 90100002 ALS 2016 Purge & Trap S/N 88145007	1988	8015, 8021 Aromatics, 8021 GRO
GC Volatiles	Agilent (Q) OI Corporation	7890A Dual PID Dual FID S/N CN12161119 4660 Concentrator S/N H216466450P 4552 Autosampler S/N US12090001	2012	8015 GRO AK 101
HPLC	Hewlett-Packard (G)	Multiple wavelength UV Detector G1365A S/N DE91600240 Fluorescence detector G1321A S/N DE92001251 Quarternary Pump G1311A S/N DE91606289	1999	8310
HPLC	Agilent Technologies (G2)	UV Diode Array Detector G1315B S/N DE11112694 Fluorescence detector G1321A S/N DE40506039 Binary Pump G1312A S/N US83105106	2011	8310, 8330
HPLC	Agilent Technologies (Q)	UV Multiple wavelength detector 1365B S/N DE11101025 Quarternary Pump G1311A S/N DE11114412	2001	8310
HPLC	Agilent Technologies (X3)	UV Diode Array Detector G1315B S/N DE23917239 Fluorescence detector G1321A S/N DE33205520 Quarternary Pump G1311A S/N DE33224364	2004	8330
HPLC	Agilent Technologies (X4)	UV Multiple wavelength detector 1365B S/N DE22601691 Quarternary Pump G1311A S/N DE14918799	2010	8330

Instrument Type	Manufacturer (Lab ID)	Model Number/ Serial Number	Year Put into Service	Method Performed
IC/MS/MS	Waters (LCMS1)	Quattro Ultima MS/MS S/N VB118 Shimadzu HPLC Pumps (2) LCIDAD UP S/N C20963952100 US S/N C20963952101 US Dionex Injector (IC) AXP-MS S/N 02080163 Conductivity Detector CD25A S/N 02010062	2000	8321, 6860
HPLC/MS/MS or IC/MS/MS	Waters (LCMS2)	Quattro Ultima MS/MS S/N VB304 Waters HPLC 2790 S/N D00SM9378M Dionex Ion Chromatography (IC) System ICS-2000 S/N 07070021	2001	8321, 6860, 6850
HPLC/MS/MS	Waters (LCMS3)	Quattro Premier XE MS/MS S/N VAB661 Waters Sample Manager Acquity S/N M04UPS473M Waters Binary Solvent Manager Acquity S/N M04UPB504M	2005	8321
HPLC/MS/MS	Waters (LCMS4)	Quattro Micromass MS/MS S/N QAA632 HPLC Inlet Acquity S/N K035M4028M Waters Ion Sabre Control Unit Ion Sabre S/N 29005	2006	8321
HPLC/MS/MS	Agilent Technologies (LCMS5)	G6460A MS/MS S/N US95270371 Agilent Binary Pump G1312B S/N DE63061753	2010	8321
CI/MS/MS	Varian (CIMS1)	1200L MS/MS S/N 1200L-680 CP-3800 GC 10828	2004	Low Level NDMA (1625)

Support Equipment				
Instrument Type	**Manufacturer**	**Model**	**Quantity**	**Location**
Centrifuge	Sorvall Legend T	Sorvall Legend T	1	Metals
Hot Block	Environmental Express	SC100 SC151 SC154	11 2 2	Metals
Sonic Bath	Bransonic	Bransonic	1	Metals
Autoclave	Tuttnaver	2340M	1	Wet Chemistry
Centrifuge	Beckman	Beckman G- D-G	1	Wet Chemistry
COD Digestor	HACH	DRB 200	2	Wet Chemistry
Cool Flow 25 NES Lab Kontes w/Midi Vap 2000	Scientific Glassware Instruments	Scientific Glassware Instruments	1	Wet Chemistry
Cyanide Digestor	Westco Scientific Instruments, Inc.	Westco Scientific Instruments, Inc.	1	Wet Chemistry
Digestion System w/ Controller	A I Scientific	AIM 500/AIM 600	2	Wet Chemistry
Incubator	Fisher Scientific	Incubator	1	Wet Chemistry
Incubator	Precision Scientific	Spore Strip Incubator	1	Wet Chemistry
Incubator	Fisher Scientific	Low Temperature Incubator	1	Wet Chemistry
Incubator	Thermo Electron Corporation	Thermo Electron Corporation	1	Wet Chemistry
Magnifier	Darkfield Quebec	Colony Counter	1	Wet Chemistry
Oil & grease Machine w/ SPE-DEX 3000 Controller/ Speed VAP II 9000 Solvent Evaporation System VAC Generator	Horizon Technology	3000 XL	1	Wet Chemistry
Oven (A)	Yamato	Mechanical Convection Oven DKN 810	1	Wet Chemistry
Oven (B)	VWR	1370 FM	1	Wet Chemistry
Oven (C)	VWR	1370 G	1	Wet Chemistry
Oven (D)	VWR	1370 GD	1	Wet Chemistry
Oven (E)	Fisher Scientific	Fisher Scientific	1	Wet Chemistry
Solvent Evaporator w/Digital Temperature Control System	UA-SYS	UA-SYS Heating System S-EVAP KD	1	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	5	Wet Chemistry
Water Bath	Fisher Scientific	Isotemp 2150	1	Wet Chemistry
Water Purifier	ELGA	Pure Lab Ultra	3	Wet Chemistry/ Bottle Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model**	**Quantity**	**Location**
Centrifuge	IEC Clinical	IEC Clinical	1	Mass Spectrometry
Centrifuge	Beckman-Coulter	Allegra X-22	1	Explosives Prep
Grinder	Humboldt	H-4199	2	Explosives Prep
Grinder	Cutler-Hammer	Ring in Puck	1	Explosives Prep
Grinder	US Stoneware	Ball mill	1	Explosives Prep
Shaker	New Brunswick Scientific	Innova 2100	1	Explosives Prep
Sonicator Bath	Branson	5510	2	Explosives Prep
Centrifuge	International Equipment Company	Model K	1	North Prep
Centrifuge	International Equipment Company	UV	1	North Prep
Drying Oven	Blue M	Temp-O-Loy Amecling Oven	1	North Prep
Microwave Extraction	CEM Corporation	MARSXpress Xtraction	1	North Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	2	North Prep
Oven	Fisher Scientific	Isotemp Muffle Furnace	1	North Prep
Sonicator	Fisher Scientific	550 Sonic Dismembrator	3	North Prep
Sonicator	Heat Systems	Sonicator Ultrasonic Processor XΔ	1	North Prep
Sonicator	Misonix	Sonicator 3000	2	North Prep
Sonicator	Heat Systems	W-385	3	North Prep
Turbo Vap	Caliper Life Science	Turbo Vap II	2	North Prep
Turbo Vap	Zymark	Turbo Vap II	1	North Prep
Water Bath	Waterlow	Waterlow	2	North Prep
Water Bath	Waterlow	Waterlow	2	North Prep
Separatory Funnel Rotators	Ap & R Machine Tool	Ap & R Machine Tool	5	North Prep South Prep
Water Purifier	ELGA	Pure lab Classic	2	North Prep South Prep
Drying Oven	Despatch	VRE2-2S-1E	1	South Prep
Hotblock	CPI	Modblock	1	South Prep
Incubated Shaker Table	Lab Line Industries, Inc.	3527	1	South Prep
Muffle Furnance	Lindberg	Lindberg	1	South Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	1	South Prep
Oven	VWR	1320	1	South Prep
Vacuum Manifold	Waters	Vacuum Manifold	2	South Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model**	**Quantity**	**Location**
Centrifuge	International Equipment Company	Model K	1	TCLP
Oven	Labline	L-C Oven	1	TCLP
Oven	Fischer Scientific	Isotemp	1	TCLP
Oven	VWR	1310	1	TCLP
Rotary Agitation Apparatus	Associated Manufacturing		3	TCLP Prep
Oven	Precision		1	GC VOA
Balance	Denver Instruments	Model: TP1502 S/N:24750526	1	GC SVOA Hood #31
Balance	Denver Instruments	Model: TP 1502 S/N: 24750525	1	GC SVOA Hood #32
Balance	Mettler	Model: AE 160 S/N: C33519	1	Metals - ICPMS
Balance	Mettler	Model: PM4000 S/N: M28318	1	Metals Prep
Balance	Denver Instruments	Model: TP 3102 S/N: 24750837	1	Hg Prep Room
Balance	Mettler	Model: AE 260 S/N: H52017	1	MS VOA Standards Prep Room
Balance	Denver Instruments	Model: TP 3102 S/N: 24950431	1	TCLP room
Balance	Denver Instruments	Model: TP 323 S/N: 24850252	1	MS VOA Hood #36
Balance	Denver Instruments	Model: TP 323 S/N: 24650437	1	MS VOA Hood #37
Balance	Mettler	Model: AE 240 S/N: I23294	1	Stnds & Aliquotting Hood #58
Balance	Denver Instruments	Model: TP 3102 S/N: 24750836	1	North Prep - MIS room
Balance	Denver Instruments	Model: TP 6101 S/N: 24750402	1	North Prep
Balance	Denver Instruments	Model: TP 6101 S/N: 24750396	1	North Prep
Balance	Denver Instruments	Model: TP 214 S/N: 24450835	1	North Prep
Balance	Denver Instruments	Model: TP 6101 S/N: 24350888	1	North Prep
Balance	Denver Instruments	Model: TP 214 S/N: 24850570	1	Wet Chem
Balance	Denver Instruments	Model: TP 6101 S/N: 24750399	1	Wet Chem

Support Equipment				
Instrument Type	**Manufacturer**	**Model**	**Quantity**	**Location**
Balance	Denver Instruments	Model: TP 6101 S/N: 24950441	1	Wet Chem
Balance	Denver Instruments	Model: TP 1502 S/N: 24650239	1	Wet Chem
Balance	Denver Instruments	Model: TP 3102 S/N: 24950432	1	Wet Chem
Balance	Mettler	Model: AE 163 S/N: D91301	1	Wet Chem /South Prep
Balance	Mettler	Model: PM 4600 S/N: H31422	1	Wet Chem
Balance	Sartorius	Model: CP124S S/N: 19350788	1	Wet Chem Soil TOC
Balance	Denver Instruments	Model: TP 214 S/N: P214088008	1	South Prep

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Cetac Mercury Analyzers	• Change Lamp • Clean cell and GLS as needed • Check pump tubing and pump flow • Check Waste Container • Fill reductant bottle with 10% Stannous Chloride and check acid reagent	As needed As needed Daily Daily Daily
ICP	• Check pump tubing • Check fluid level in waste container • Clean or replace air filters • Check torch for residue • Check nebulizer flow • Clean nebulizer and drain chamber • Fill rinse solution/ IS solution • Replace capillary tubing/sipper probe • Change internal cooling fluid	Daily Daily As needed Daily Daily Daily Daily As needed Quarterly
ICP MS	• Change pump tubing • Check level of tuning solution • Check waste container • Load printer with paper • Check air filters • Replace coolant on chiller • Clean or change nebulizer • Clean or replace torch • Replace sample tubing • Change oil in vacuum pumps • Remove and clean cones	Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed
UV-Vis Spectrophotometer	• Clean ambient flow cell • Precision check/alignment of flow cell • Wavelength verification check	As required As required Semi-annually
Colorimetric Analyzer	• Clean detector • Clean filters • Check tubing • Clean sample probe shaft • Clean pump, diluter, and XYZ sampler. • Lubricate pump roller	Daily Daily Daily Daily Monthly Semi-annually

Instrument	Procedure	Frequency
Ion Chromatograph	• Check plumbing for leaks • Check gases • Check pump pressure • Check eluent level • Check conductivity meter • De-gas pump head when flow is erratic • Change analytical columns and bed supports guard • Check and replace any damaged/discolored tubing	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Total Organic Halide Analyzer	• Check electrodes/polish if needed • Replace dehydrating fluid /electrolyte fluid • Clean quartz boat • Perform cell performance check • At the end of each day of use, wash out the absorption module, empty the electrolyte and fill chamber with DI water, empty dehydrator tube • Clean or replace pyrolysis tube • Clean titration cell • Replace reference electrode fluid • Change quartz wool • Replace o-rings and seals	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Hewlett Packard GC/MS	• Check Septa and clean injection port • Check carrier gas supply • Check tune parameters • Check oil levels in mechanical pumps and the diffusion pump if the vacuum is insufficient • Replace electron multiplier • Clean Source • Replace filaments • Change rough pump oil and exhaust filters • Relubricate the turbomolecular pump-bearing wick	Daily Daily Daily As needed As needed As needed As needed Annually Annually
Gas Chromatograph	• Check carrier gas supply • Check temperatures of inlet, detectors, verify temperature program • Check septa clean injection port or replace injection port liner and cut column if needed • Reactivate carrier gas drying agents • Replace or repair flow controllers if constant flow cannot be maintained	Daily Daily As needed As needed As needed

Instrument	Procedure	Frequency
Electron Capture Detector (ECD)	• Detector wipe test (Ni-63) • Detector cleaning	Semi-annually As needed
Flame Ionization Detector (FID)	• Detector cleaning	As needed
Nitrogen Phosphorus Detector (NPD)	• Replace bead • Replace ceramic rings	As needed As needed
Photoionization Detector (PID)	• Change O-rings • Clean lamp window	As needed As needed
HPLC	• Check level of eluent vessels • Change pump seals • Change the column frit • Change fuses in power supply • Filter all samples • Change autosampler rotor or oil autosampler slides • Change or backflush columns • Replace needle • Replace needle seat assembly • Replace Active Inlet Valve (AIV) cartridge • Replace lamps	Daily As needed As needed As needed Daily As needed As needed As needed As needed As needed As needed
APCI/ESI LC/MS/MS	• Check solvent reservoirs • Verify that pump is primed and operating pulse free • Verify temperatures for capillary heater/vaporizer heater • Verify pressure of manifold/fore-pump • Verify that corona and multiplier are functional • Clean Lenses • Clean skimmer • Replace column • Oil autosampler • Change autosampler filters • Replace sample inlet tube • Replace fused silica tubing at ESI interface • Replace rough pump oil • Replace turbo pump oil • Vacuum system components including fans and fan covers	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed Annually Annually Annually
Balances	• Class "S" traceable weight check • Clean pan and check if level • Field service	Daily, when used Daily At least Annually
Sonicator	• Inspect probe for etching/pitting • Tune sonicator assembly • Disassemble and clean probe tips	Daily Weekly As needed

Instrument	Procedure	Frequency
Conductivity Meter	• Standardize with KCL • Conductivity cell cleaning • Check probes and cables	Daily As needed As needed
Flash Point Tester	• Check stirrer • Check tubing • Check gas supply • Check thermometer against NIST thermometer	Daily Daily Daily Quarterly by QA
Digestion Block	• Check with NIST thermometer	Annually
Turbidimeter	• Check light bulb • Inspect cells • Clean housing	Daily, when used Monthly Monthly
Deionized/Distilled Water	• Conductivity check • System cleaning • Replace cartridge & large mixed bed resins	Daily As needed As needed
Drying Ovens	• Temperature monitoring • Temperature adjustments	Daily As required
Refrigerators/ Freezers	• Temperature monitoring • Temperature adjustment • Defrosting/cleaning	Daily As required As required
pH/Specific Ion Meter	• Calibration/check slope • Clean electrode	Daily As required
BOD Incubator	• Temperature monitoring	Daily
Water baths	• Temperature monitoring • Water replaced	Daily Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

Calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to TestAmerica Denver contains, in a well designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis

upon which they were made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, TestAmerica Denver does not use a firm who subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation) with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. [Refer to TestAmerica's Corporate SOP (CA-Q-S-001), *Solvent and Acid Lot Testing and Approval.*]

All manufacturer or vendor supplied Certificates of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the analytical groups and by QA on the public drive. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to Denver SOP DV-QA-0015, *Verification and Storage of Calibration Standards.*

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date

- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID
- Special Health/Safety warnings if applicable

Note: Reagents that are not prepared and used directly from the vendor bottle only need to have a lot number, open date and expiration date.

Records must be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in the LIMS and TestAmerica Intranet Oasis.

21.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of

holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & subsampling are located in SOP # DV-QA-0023, *Subsampling.*

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the COC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

All samples are tracked through the LIMS software program to ensure internal chain of custody and cradle to grave tracking of each sample container. If samples are identified for

legal/evidentiary purposes on the COC an internal COC can be generated from the LIMS and included in the data package.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

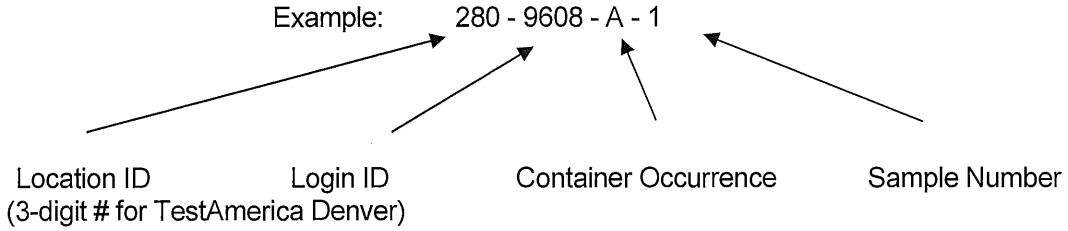
23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Condition Upon Receipt Anomaly Form (CUR) and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record. Refer to SOP DV-QA-0003, *Sample Management and Chain of Custody* for detailed information on receipt of samples.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that TestAmerica Denver Laboratory (Location 280). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 280 - 9608 - A - 1 - **A** ←——**Secondary Container Occurrence**

Example: 280-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- all samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time;
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP No. DV-QA-0003, *Sample Management and Chain of Custody.*

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix, except metals sample containers which may be stored unrefrigerated. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator, document the transfer of containers in LIMS and place them on carts, analyze the sample, and return the remaining sample to the refrigerator from which it originally came, documenting the return in LIMS. Empty containers are stored in the sample archive area until disposal, this transfer is documented in LIMS. All samples are kept in the refrigerators until the project is invoiced. At this time, the samples will be retained for an additional thirty days, either in the refrigerators, or in the sample archive area. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues. Upon disposal, the drum number used for disposal is logged into LIMS.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in a designated area. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, the analyst will notify login staff so the hazardous sample is properly labeled as such. The sample itself is clearly marked with a label reading "HAZARDOUS", "PCBs" or "FOREIGN SOIL". All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm. All foreign soil samples are sent out for incineration

by a USDA-approved waste disposal facility; refer to SOP DV-QA-0019, *Quarantine Soils Procedure* for more detail.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: DV-HS-0005, *Excess Sample Material Management).* All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

All documentation and correspondence concerning the disposal of samples is kept on file. The LIMS Internal Chain of Custody software allows tracking for each sample container from the time of sample receipt through the disposal process, including such detail as the identifying number of the waste drum used for disposal. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Hazardous Waste Manifest will be prepared to document the disposal of each drum. Additional detail is in SOP DV-HS-0004, *Hazardous Waste Manifesting.*

Figure 23-1. Example: Chain of Custody (COC)

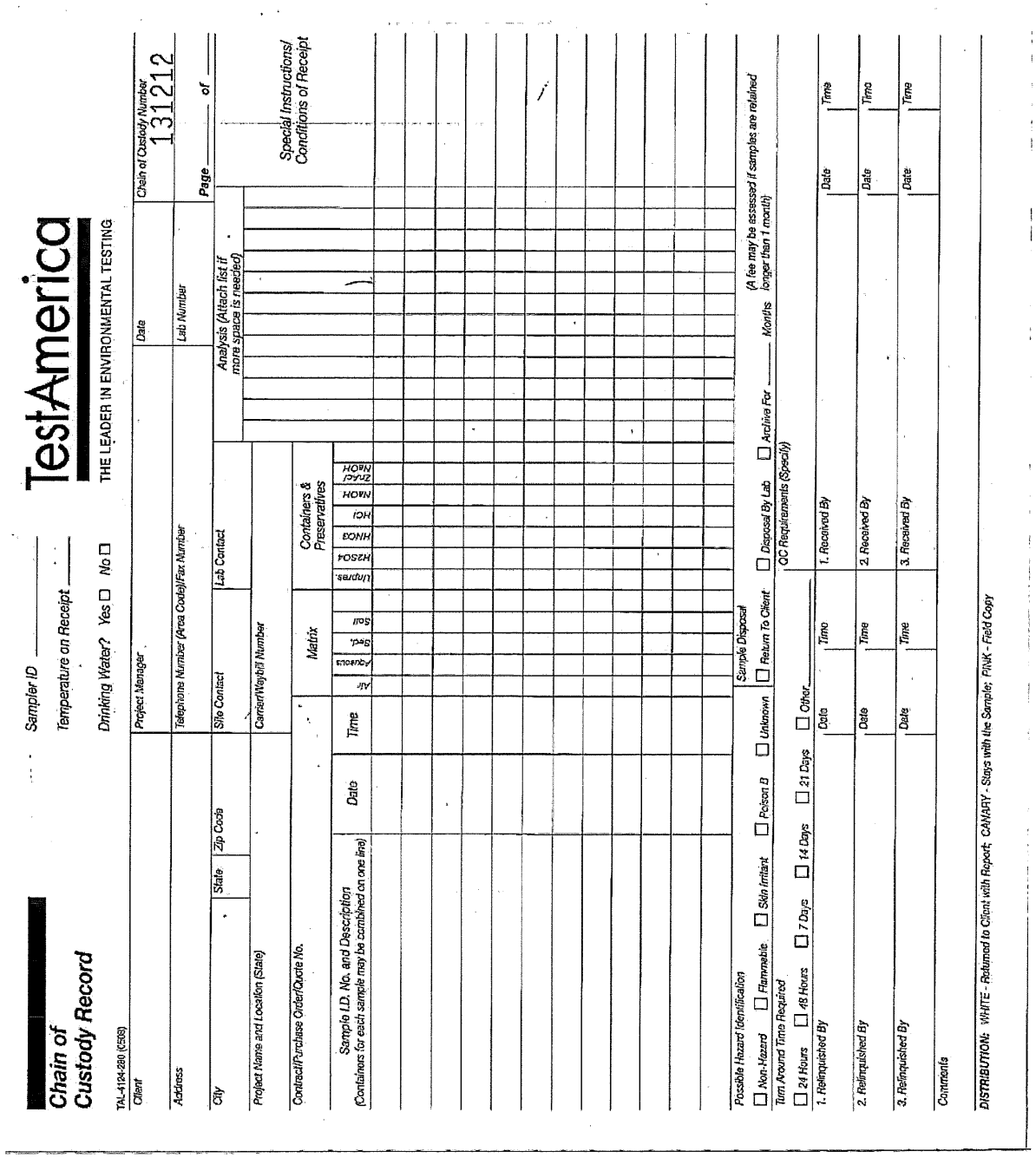


Figure 23-2. Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
   - Client name, address, phone number and fax number (if available)
   - Project name and/or number
   - The sample identification
   - Date, time and location of sampling
   - The collectors name
   - The matrix description
   - The container description
   - The total number of each type of container
   - Preservatives used
   - Analysis requested
   - Requested turnaround time (TAT)
   - Any special instructions
   - Purchase Order number or billing information (e.g. quote number) if available
   - The date and time that each person received or relinquished the sample(s), including their signed name.
   - The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab, and they must be exactly the same.
   - Information must be legible

2) Samples must be properly labeled.
   - Use durable labels (labels provided by TestAmerica are preferred)
   - Include a unique identification number
   - Include sampling date and time & sampler ID
   - Include preservative used.
   - Use indelible ink
   - Information must be legible

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. See Lab Sampling Guide.

4) Samples must be preserved according to the requirements of the requested analytical method (See Sampling Guide.

5) Most analytical methods require chilling samples to 4° C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6° C and above freezing (0°C). For methods with other temperature criteria (e.g. some bacteriological methods

require $\leq$ 10 °C), the samples must arrive within $\pm$ 2° C of the required temperature or within the method specified range.

Note: Samples that are hand delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

- Chemical preservation (pH) will be verified prior to analysis and the project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- For Volatile Organic analyses in drinking water (Methods 502.2 or 524.2). Residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  - 1. Test for residual chlorine in the field prior to sampling.
    - If no chlorine is present, the samples are to be preserved using HCl as usual.
    - If chlorine is present, add either ascorbic acid or sodium thiosulfate prior to adding HCl.
  - 2. Use VOA vials pre-preserved with sodium thiosulfate or ascorbic acid and add HCl after filling the VOA vial with the sample.

- **FOR WATER SAMPLES TESTED FOR CYANIDE (by Standard Methods or EPA 335)**

  - In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH.

    - If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered and qualify the results in the final report.

  - It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.

  - The laboratory must test the sample for oxidizing agents (e.g. Chlorine) prior to analysis and treat according to the methods prior to distillation. (ascorbic acid or sodium arsenite are the preferred choice).

6) Sample Holding Times
   - TestAmerica will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48hr HT) sample must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

   - Analyses that are designated as "field" analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field

sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, TestAmerica will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for "field" analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. The actual times of all "field" sample analyses are noted on the "Short Hold Time Detail Report" in the final report. Samples analyzed in the laboratory will be qualified on the final report with an 'H' to indicate holding time exceedance.

7) All samples submitted for Volatile Organic analyses must have a Trip Blank submitted at the same time. TestAmerica will supply a blank with the bottle order.

8) The project manager will be notified if any sample is received in damaged condition. TestAmerica will request that a sample be resubmitted for analysis.

9) Recommendations for packing samples for shipment.

   - Pack samples in Ice rather than "Blue" ice packs.
   - Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
   - Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
   - Fill extra cooler space with bubble wrap.

Figure 23-3. Example: Cooler Receipt Form

TestAmerica Denver
Sample Receiving Checklist

Login #:_____ Date/Time Received:_____

Company Name & Sampling Site: _____

PM/PMA to Complete This Section at Cooler Greet: *Yes* *No* *Yes* *No*
Residual chlorine check required: ☐ ☐ Quarantined: ☐ ☐

TALS Project #:
Special Instructions:

Time Zone: • EDT/EST • CDT/CST • MDT/MST • PDT/PST • OTHER State:

PM/PMA to Complete This Section Upon Review:
Matrix/Count: Field QC samples: Client Requested MS/MSD:

Document any problems or discrepancies and the actions taken to resolve them on a Condition Upon Receipt Anomaly Report (CUR)

Unpacking Checks: ***Initials*** _____

Temperatures (°C): _____ _____ _____ _____ _____ _____ _____ _____

N/A	*Yes*	*No*	
☐	☐	☐	1. Is radioactivity at or below background? BKG CPM:_____ CPM Reading: _____
☐	☐	☐	2. Is the cooler's custody seal intact? Do cooler or samples appear to not have been compromised or tampered with?
☐	☐	☐	3. Were samples received on ice? Is cooler temperature acceptable? Has temperature been recorded?
☐	☐	☐	4. Is COC present; filled out in ink and legible; and filled out with all pertinent information?
☐	☐	☐	5. Is the Field Sampler's name present on the COC?
☐	☐	☐	6. Are there no discrepancies between the sample IDs on the containers and the COC?
☐	☐	☐	7. Are samples received within Holding Time?
☐	☐	☐	8. Do sample containers have legible labels?
☐	☐	☐	9. Are all sample containers intact (not broken or leaking)?
☐	☐	☐	10. Are appropriate sample containers used? Are sample bottles completely filled? Is sufficient vol. for all requested analyses, incl. any requested MS/MSDs provided?
☐	☐	☐	11. No splitting or compositing of samples required?
☐	☐	☐	12. Was Sample Preservation verified and found to be correct?
☐	☐	☐	13. Do all VOA sample vials have no headspace or bubbles >6 mm (1/4") in diameter?
☐	☐	☐	14. Were VOA vials labeled as preserved? Preservative ☐ HCl ☐ 0-6°C ☐ Sodium Thiosulfate ☐ Ascorbic Acid
☐	☐	☐	15. Are all samples single phase? (i.e., no multiphasic samples are present.)
☐	☐	☐	16. Was Residual Chlorine checked and noted on the CUR if present?

Login Checks: ***Initials*** _____

☐	☐	☐	17. Was a Priority Form completed for any short holds or quick TATs?
☐	☐	☐	18. Were any tests logged for subcontract?
☐	☐	☐	19. Were special archiving instructions and login instructions indicated in the Project Notes?

Note Archive Requirements: _____

☐	☐	☐	20. Were multiple Series logged for this job?

Labeling and Storage Checks: ***Initials*** _____

☐	☐	☐	21. If subcontract work was requested, was volume placed on sub shelf?
☐	☐	☐	22. Did the sample ID on TA label match the client's sample ID on container? ***Verified by:*** _____
☐	☐	☐	23. Were stickers for special archiving instructions affixed to each box?

SDG labels applied ***(initials):*** _____ ***Verified by:*** _____

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g., Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, evaporation, and drying. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	Used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above ½ the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	Prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	Blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [1]	Required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	Sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	Also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (**TNI**)
Holding Blanks	Also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 **Negative Controls for Microbiological Methods** – Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	Analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.
Filtration Blanks	Blanks that are run at the beginning and end for each sterilized filtration unit used in a filtration series. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility checks (Sample Containers)	Performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.
Sterility Checks (Dilution Water)	Performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	Also performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms.

Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However,

in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.4.2 Positive Controls for Microbiological Methods

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	Used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects.If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.

Table 24-3. Sample Matrix Control

Control Type	Details	
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.
[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on a semi-annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically

derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

- If either the high or low end of the control limit changes by $\leq$ 5% from previous, the control chart is visually inspected and, using professional judgment, the limit(s) may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer to Denver SOP DV-QA-003P, *Quality Assurance Program* for a detailed description of the control charting procedure.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with a LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI and Department of Defense (DoD) work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).

- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be

located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedences may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additonal Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.
-

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation

requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Analytical Report For Samples) with a "sample results" column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. job number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

25.2.11 Reporting Limits

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.22 The laboratory includes a cover letter.

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 Non-accredited tests shall be clearly identified in the case narrative when claims of accreditation to the TNI standard are made.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above. TestAmerica Denver rarely utilizes this report.
- Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. The Denver laboratory offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), Excel, Dbase, GISKEY, SEDD 2A, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific

electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by telephone at the 1-800-765-0980 (or for e-mails: please notify us immediately by e-mail or by phone (1-800-765-0980) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the job number followed by "Rev#".

When the report is re-issued, a notation of "revised report "is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example: Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

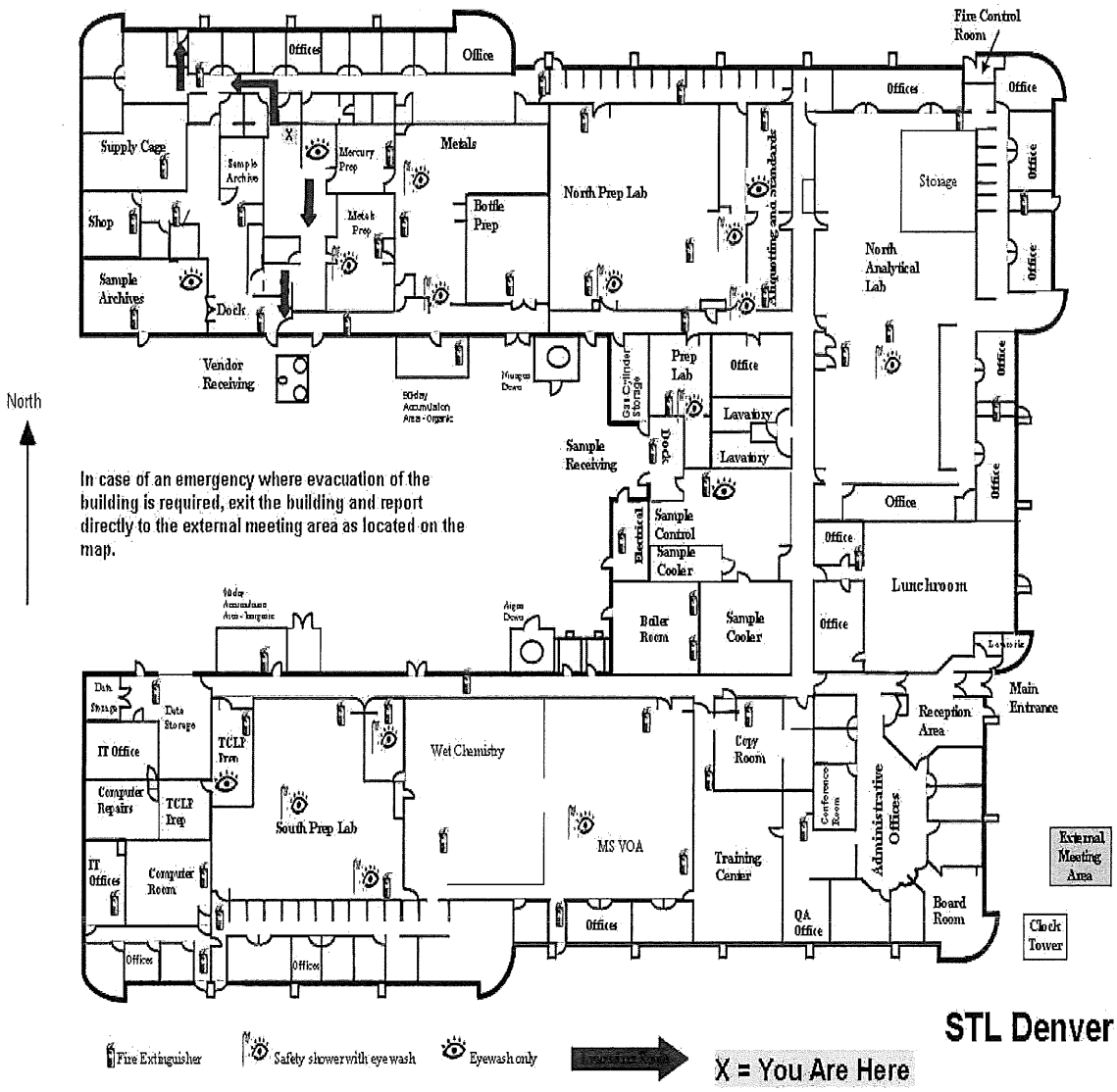
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Aliquot, aliquant: A measured portion of a sample taken for analysis.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Air & Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification check standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan

RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
TNI – The NELAC Institute
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Denver maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Lab ID	Program	Authority
2907.01	DoD ELAP	A2LA
	ISO/IEC 17025	A2LA
E87667	NELAC Primary AB	Florida
200017	NELAC Secondary AB	Illinois
E-10166	NELAC Secondary AB	Kansas
30785	NELAC Secondary AB	Louisiana
	NELAC Secondary AB	New Hampshire
	NELAC Secondary AB	New Jersey
11964	NELAC Secondary AB	New York
CO200001	NELAC Secondary AB	Oregon
68-00664	NELAC Secondary AB	Pennsylvania
T104704183-08-TX	NELAC Secondary AB	Texas
QUAN5	NELAC Secondary AB	Utah
	State Program	Alabama
UST-30	State Program	Alaska
AZ0713	State Program	Arizona
88-0687	State Program	Arkansas
2513	State Program	California
N/A	State Program	Colorado
486-03	State Program-RAM license	Colorado
PH-0686	State Program	Connecticut
N/A	State Program	Georgia
CO00026	State Program	Idaho
370	State Program	Iowa
CO0002	State Program	Maine
268	State Program	Maryland
8-999-405	State Program	Minnesota
CO0026	State Program	Nevada
N/A	State Program	New Mexico
358	State Program	North Carolina
R-034	State Program	North Dakota
8614	State Program	Oklahoma
72002	State Program	South Carolina
TN02944	State Program	Tennessee
C1284	State Program	Washington
354	State Program	West Virginia
999615430	State Program	Wisconsin
P330-08-00036	USDA	

The certificates and parameter lists (which may differ) are available, upon request, from a laboratory representative. for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Title: Gas Chromatographic Analysis of Total Petroleum Hydrocarbons [Methods AK 102/103, SW846-8015B, CA-LUFT, NWTPH-Dx]

Approvals (Signature/Date):

Steve Rogers
Technical Manager
9/7/12
Date

Joe Schairer
Health & Safety Manager / Coordinator
9/7/2012
Date

Douglas Weir
Quality Assurance Manager
for: DJW 9/10/12
Date

Karla Buechler
Laboratory Director
9/10/12
Date

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1. SCOPE AND APPLICATION

1.1. This SOP describes procedures to be used for determination and/or quantitation of semivolatile hydrocarbon mixtures that elute between n-C8 (octane) and n-C36 (hexatriacontane). Extension of the chromatographic run to include to n-C40 (tetracontane) may be performed as a client-specific measure. This SOP is applicable to extracts that are prepared according to the appropriate sample extraction SOPs (WS-OP-0004).

1.2. Table 1 lists hydrocarbon fuel mixtures that are routinely determined by this method and gives the Reporting Limits (RL) for each matrix. RLs are based on the low level standard and the sample preparation concentration factors. Matrix interferences or limited sample volume may result in higher RLs than those listed.

1.3. This method is designed to measure mid-range petroleum products such as Diesel #2 or motor oil utilizing methods AK102/103, SW846-8015B, CA-LUFT, or NWTPH-Dx.

1.4. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. This method presents conditions for the analysis of prepared extracts for hydrocarbon fuel mixtures. The extracts are injected onto the column and separated and detected by flame ionization detection. Quantitation is by the external standard method.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Contamination by carryover can occur when a low concentration sample is analyzed after a high concentration sample. Co-elution of target analytes with non-targets can occur, resulting in false positives or biased high results. In particular, this is a problem with non-selective detectors such as the Flame Ionization Detector (FID).

4.2. Interferences in the GC analysis arise from many compounds amenable to gas chromatography that give a measurable response on the flame ionization detector.

Phthalate esters, which are common plasticizers, can pose a major problem in the determinations. Interferences from phthalates are minimized by avoiding contact with any plastic materials.

4.3. Other organic compounds including animal and vegetable oil and grease, chlorinated hydrocarbons, phenols and phthalate esters are measurable under the conditions of this method. As defined in the method, the unknown hydrocarbon results include these compounds.

4.4. Interferences co-extracted from samples will vary considerably from source to source. The presence of interferences may raise quantitation limits for individual samples. Specific cleanups may be performed on the sample extracts, including silica gel cleanup. These cleanup procedures are included in SOP WS-OP-0004.

4.5. Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of a solvent blank to check for carryover.

4.6. Petroleum products are complex mixtures of compounds derived from crude petroleum, and different products may have overlapping boiling ranges and chromatograms. The products are also subject to degradation in the environment with consequent changes in the chromatographic profile. When such changes are considerable, it may not be possible to positively identify the parent mixture.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002), and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Nitrile gloves should be used when working with solvent or extract containers. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP, and should not be used.

5.1.2. Ensure that all instrument exhaust vents and lines are properly connected to either a laboratory vent or an appropriate filter. Instruments may not be

vented to the working environment.

5.1.3. Exposure to chemicals must be maintained as low as reasonably achievable. All preparation of standards and dilutions shall be performed inside an operating fume hood. All samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.4. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

An analytical system complete with a gas chromatograph is required. A data system capable of measuring peak area and/or height is required. Recommended equipment and supplies for individual methods are listed in each method appendix.

6.1. Preventive and routine maintenance is described in the "Schedule of Routine Maintenance" in the QAM, Preventative Maintenance (Section 20.2) and Schedule of Routine Maintenance (Table 20.2).

6.2. Gas Chromatograph - Agilent model 6890N or equivalent.

6.2.1. Autosampler – Agilent model 76373, 7683B or equivalent.

6.2.2. Operating System – Agilent NSD Chem Station D.02-00-275 or equivalent.

6.2.3. Software version – Target Rev. 4.14 Build 10 or equivalent and Chrom Peak Review, Version 2.1.4608.20933 or equivalent..

6.3. Preventive and routine maintenance is described in the "Schedule of Routine Maintenance" in the QAM, Preventative Maintenance (Section 20.2) and Schedule of Routine Maintenance (Table 20.2).

6.4. Refer to Table 3 for analytical column and conditions.

6.5. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Neat Standard Materials

Hydrocarbon fuels are generally available as stock solutions from commercial vendors. In rare instances when they are not available from vendors, neat materials may be acquired directly from the client. Such neat materials expire following a period of 3 years from the date of receipt, or sooner if problems such as pattern degradation or linearity loss occur.

7.2. Stock Standards

Stock standards are purchased as certified solutions or prepared from pure solutions. Standard solutions are stored at 4 ± 2°C. All stock standards must be protected from light. Stock standard solutions should be brought to room temperature before using.

Stock standard solutions must be replaced after six months (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Stocks may be replaced sooner if comparison with check standards prepared from an independent source indicates a problem.

7.3. Calibration Standards

Calibration standards are prepared as dilutions of the stock standards. Surrogate standards are used as specified. Calibration solutions must be refrigerated at 4 ± 2°C

and protected from light. The standards are given a 6 month expiration date from the time of preparation, or the expiration date of the stock solution, whichever is sooner. Standards `may be replaced sooner if there is reason to believe that the standard has degraded or concentrated or if comparisons with check standards indicates a problem.

Refer to Table 3 for details of calibration standards.

7.4. Surrogate Standards

7.4.1. Ortho-terphenyl is the surrogate standard. Refer to Tables 4 and 6 for details of the surrogate standard.

7.4.2. The surrogate n-triacontane-d62 is required for most AFCEE projects and may be used as a surrogate for AK103 (RRO) analysis. Refer to Tables 4 and 6 for details of this surrogate standard.

7.5. Alkane Range

A single level standard containing the even-numbered alkanes from n-C8 to n-C40 and C25, is used to set retention time windows for fuel identification and quantitation. This may be made from two commercially available standards, one containing the even numbered alkanes, and an Alaska-specific solution containing C1-, C25, and C36. The alkane range solution has an expiration of one year from date of preparation or the manufacturer's expiration of the solution(s) from which it is diluted, whichever is earlier. Refer to Table 5 for details of the alkane range standard.

7.6. Gases for carrier, make-up, and detector fuel: hydrogen, and nitrogen, and air.

7.7. Quality Control (QC) Standards

QC standards (matrix spiking and LCS standards) are prepared and stored in the same way as calibration standards. They must be made from a stock independent from the calibration standards.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Semivolatile extracts must be refrigerated at $4 \pm 2^{\circ}$C. Aqueous samples must be extracted within 7 days of collection and solid samples within 14 days of collection. Extracts must be analyzed within 40 days.

8.2. Aqueous samples for analysis by NWTPH methods must be extracted within 7 days of collection unless the sample is preserved to pH<2. In that case, the samples must be extracted within 14 days of collection.

8.3. Aqueous samples for analysis by AK102 must be preserved to pH < 2 and extracted within 14 days of collection. Solid samples for both AK methods must be extracted

within 14 days of collection. All samples for both AK methods must be analyzed within 40 days of collection (not extraction).

NOTE: Holding times for AK methods are calculated to the hour.

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability

9.1.1. For the standard analyte list, the initial demonstration and method detection limit (MDL) studies described in Section 13 must be acceptable before analysis of samples may begin.

9.1.2. For non-standard analytes, an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is the analysis of a single point calibration standard.

9.2. Quality Control Batch

The batch is a set of up to 20 field samples that are of the same matrix and are processed together using the same procedures and reagents. The batch must contain a method blank, an LCS and a matrix spike/matrix spike duplicate. (In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD). If clients specify particular samples for MS/MSD, the batch may contain multiple MS/MSDs. See policy WS-PQA-003 for further definition of the batch.

Batches are defined at the sample preparation stage. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. Refer to the QC Program document (WS-PQA-003) for further details of the batch definition.

9.3. Control Limits

In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). Refer to policy WS-PQA-003 for more details.

9.3.1. These limits do not apply to dilutions (except for tests without a separate extraction). Surrogate and matrix spike recoveries will be reported unless the dilution is more than 5X.

9.3.2. All surrogate, LCS, and MS recoveries (except for dilutions) must be entered into QuantIMS or other database so that accurate historical control limits can be generated. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.3.3. Refer to the QC Program document (WS-PQA-003) for further details of

control limits.

9.3.4. Refer to Table 10 for AK 102/103 recovery requirements for surrogates and laboratory control samples (LCS/LCSD) and RPD (Relative Percent Deviation).

9.4. Surrogates

Surrogate recoveries in field samples and QC samples must be assessed to ensure that recoveries are within established limits. If any surrogates are outside limits, the following corrective actions must take place (except for dilutions):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem.
- Reprepare and reanalyze the sample or flag the data as "Estimated Concentration" if neither of the above resolves the problem. Repreparation is not necessary if there is obvious chromatographic interference.
- The decision to reanalyze or flag the data should be made in consultation with QA and the client. It is only necessary to reprepare/reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect.

9.4.1. If the surrogates are out of control for the sample, matrix spike, and matrix spike duplicate, then matrix effect has been demonstrated for that sample and repreparation is not necessary. If the sample is out of control and the MS and/or MSD is in control, then repreparation or flagging of the data is required.

9.4.2. Refer to the QC Program document (WS-PQA-003) for further details of the corrective actions.

9.5. Method Blanks

One method blank must be processed with each preparation batch. The method blank consists of reagent water for aqueous samples. Surrogates are added and the method blank is carried through the entire analytical procedure. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data. The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, see below) or at or above 10% of the

measured concentration of that analyte in the associated samples, whichever is higher. Certain programs, such as USACE, may require a more stringent evaluation of the method blank, for instance, that the blank not contain any analytes of interest at a concentration greater than ½ the reporting limit.

9.5.1. Re-preparation and reanalysis of any samples with reportable concentrations of analytes less that 10 times the value found in the method blank is required unless other actions are agreed with the client.

9.5.2. If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported. This must be documented in the NCM program.

9.5.3. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all positive results in associated samples are flagged with a "B", and appropriate comments may be made in a narrative to provide further documentation.

9.5.4. Refer to the QC Program document (WS-PQA-003) for further details of the corrective actions.

9.6. Laboratory Control Samples (LCS)

9.6.1. For each batch of samples, analyze an LCS. The LCS contains a representative subset of the analytes of interest, and must contain the same analytes as the matrix spike. The LCS may also contain the full set of analytes. If any analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur.

9.6.1.1. LCS compound lists are included in Table 6.

9.6.1.2. For AK Methods (AK102; AK103) prepare and analyze an LCS Duplicate sample as well as an LCS sample for each component of interest (DRO, RRO) for each analytical batch.

9.6.2. If any analyte in the LCS is outside the laboratory established historical control limits, corrective action must occur:

- Check calculations,
- Check instrument performance,
- Reanalyze the LCS, and if still outside of control limits,
- Evaluate the data, and/or
- Re-prepare and reanalyze all samples in the QC batch.

9.6.3. Data may be reported with an anomaly in the following cases:

- The LCS recoveries are high and the analyte of concern is not detected in field samples,
- All requested target analytes are within control, but other LCS compounds are out of control.

9.6.4. The analyst should evaluate the anomalous analyte recovery for possible trends.

9.6.5. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report.

9.6.6. If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.

9.6.7. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.7. Matrix Spikes

For each QC batch, analyze a matrix spike and matrix spike duplicate. Spiking compounds and levels are given in the appendices. Compare the percent recovery and relative percent difference (RPD) to those in the laboratory specific historically generated limits.

9.7.1. If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in the Laboratory Control Sample (LCS). Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed.

9.7.2. If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the laboratory is out of control and corrective action must be taken. Corrective action will normally include repreparation and reanalysis of the batch.

9.7.3. If a MS/MSD is not possible due to limited sample, then a LCS duplicate may be analyzed.

9.7.4. The MS/MSD must be analyzed at the same dilution as the unspiked sample, unless the matrix spike components would then be above the calibration range.

9.7.5. If the amount of an analyte found in the unspiked sample is greater than 4 times the amount of spiked analyte added, then routine control limits do not apply and recoveries are not evaluated. Other analytes in the MS and MSD

must still be reported. File an NCM stating that the 4X rule was applied. This NCM must be included in the final report.

9.8. Insufficient Sample

If insufficient sample is available to process a MS/MSD, then a second LCS may be processed, if precision data is required by the client. The LCS pair is then evaluated according to the MS/MSD RPD criteria. Use of an LCS pair in place of an MS/MSD must be documented using Clouseau.

9.9. Initial Calibration Verification (ICV) -- When available, a second source standard is analyzed with the initial calibration curve. Each compound of the second source calibration must be within ± 15% of its expected value, when evaluated with respect to the calibration curve. Exceptions are ± 20% for QSM and ± 25% for AK projects. Corrective actions for the ICV include:

- Rerun the ICV
- Remake or acquire a new ICV
- Evaluate the instrument conditions
- Evaluate the Initial Calibration Standards

9.10. Quality Assurance Summaries

Certain clients may require specific project or program QC which may supersede these method requirements. Quality Assurance Summaries should be developed to address these requirements.

9.11. Nonconformance and Corrective Action

Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the QA Manager.

9.12. QC Program

Further details of QC and corrective action guidelines are presented in the QC Program document (WS-PQA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION

10.1. Initial Calibration

10.1.1. External calibration is used. Prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given in Table 4.

10.1.2. The alkane range standard should be run with the initial calibration. If the

initial calibration consists only of add-on mixtures, and the current diesel fuel calibration standards indicate that no peak shifting has been occurring, analysis of the alkane standard may be waived.

10.1.3. Quantitation of hydrocarbon mixtures

10.1.3.1. Starting and ending retention times for quantitation are determined for each fuel. The peak areas between the starting and ending times are summed and used to generate a response factor. This factor is used to quantitate sample results, and depending on the client requirements, this factor may be applied to the same retention range as the standard, or to a different range.

10.1.3.2. See Table 2 for details of the commonly used retention and quantitation ranges.

10.1.3.3. When setting starting and ending retention times based on Table 2 ranges (or other commonly used ranges), the start of the range should be set ± 0.1 minute before the first marker peak and end ± 0.1 minute before the last marker peak. The retention times of the apexes of the marker peaks should not be used as the retention time windows for the fuels.

10.1.4. Analyze an ICV (Section 9.9) immediately following the calibration curve. This verification standard is used as a quality control check to verify the accuracy of the calibration.

10.2. A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include new columns, or changing PID lamps or FID jets, and any changes in instrument operating parameters, including gas flows, detector temperatures, oven temperatures, etc.

10.3. With the exception of instances detailed in Policy CA-T-P-002, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in the calibration curve.

10.4. Quantitation by the external standard method assumes a proportional relationship between the calibration run and the analyte in the sample. To use this approach introduce each calibration standard into the GC using the technique that will be used for samples. The ratio of the peak height or area response to the mass or concentration injected may be used to prepare a calibration curve.

Equation 1

$$Calibration\ Factor\ (CF) = \frac{Area\ of\ Peak(s)}{Concentration\ of\ Standard\ (ng/ml\ or\ ug/ml)}$$

Due to the nature of hydrocarbon fuels, peak height may not be used for quantitation. Variations on this formula are permitted so long as the calculations between standards and samples remain consistent.

10.5. Average response factor or linear regression may be used to fit the data. Linear regression may be used if the calibration range is sufficiently narrow so that a straight line will fit the calibration points. Average response factor may be used if the %RSD of the response factors or calibration factors is ≤ 20%.

10.5.1. Average response factor

10.5.1.1. The average response factor may be used if the percent relative standard deviation (%RSD) of the response factors is ≤ 20%.

10.5.1.2. The equation for average response factor is:

Equation 2

$$\text{Average response factor} = \frac{\sum RF_{1-n}}{n}$$

Where: n = Number of calibration levels

$\sum RF_{1-n}$ = Sum of response factors for each calibration level

10.5.2. Linear regression

10.5.2.1. The linear fit uses the following function:

Equation 3

$$Concentration = A + BR$$

Where: A = Intercept

B = Slope

R = Response

10.6. Evaluation of calibration curves

10.6.1. The percent relative standard deviation (%RSD), or percent relative standard error (%RSE) for non-average response factor calibration models, from the calibration curve is used to evaluate the initial calibration. This provides a measure of how much error is associated with using the calibration curve for quantitation.

10.6.2. The least squares regression line is calculated and used to calculate the predicted concentration for each level.

10.6.2.1. The percent relative standard error (%RSE) is calculated as follows:

Equation 4

$$\%\ RSE = 100\% \times \sqrt{\frac{\sum_{i=1}^{N}\left[\frac{Ci - PCi}{Ci}\right]^2}{(N-P)}}$$

Where:

N = Number of points in the curve

P = Number of parameters in the curve (= 1 for average response factor, 2 for linear, 3 for quadratic)

C_i = True concentration for level i

PC_i = Predicted concentration for level i

Note that when average response factors are used, this equation gives the same value as the %RSD of the response factors.

10.6.2.2. Percent relative standard deviation is calculated as follows:

Equation 5

$$\%\ RSD = 100\% \times \frac{\sqrt{\frac{\sum_{i=1}^{N}\left[RF_i - \overline{RF}\right]^2}{N-1}}}{\overline{RF}}$$

Where:

N = Number of points in the curve

RF_i = Response factor calculated for level i

$\overline{RF}$ = Average response factor

10.7. The following requirements must be met for any calibration to be used:

- Response must increase with increasing concentration.
- If a curve is used, the intercept of the curve at zero response must be less than ± the reporting limit for the analyte.
- Relative standard deviation (or RSE) of the calibration points from the curve used must be ≤ 20%.
- In some cases, (normalized) %RSD may not be appropriate (i.e., curve fits without 1/Concentration^2 weighting). In this case, the correlation coefficient may be used as an alternative to the %RSD, and must be greater than 0.990.

Note: The normalized %RSD is superior to the Correlation Coefficient (r) and Coefficient of Determination (r^2) for testing the fit of a set of calibration points to a line. The lower points on a curve have little effect on r. As a result a curve may have very good correlation coefficient (>0.995), while also having >100% error at the low point.

10.7.1. Weighting of data points

10.7.1.1. In a linear calibration fit, the points at the lower end of the calibration have less weight in determining the curve generated than points at the high concentration end of the curve. However, in environmental analysis, accuracy at the low end of the curve is very important. For this reason it is preferable to increase the weighting of the lower concentration points. $1/Concentration^2$ weighting (often called $1/X^2$ weighting) will improve accuracy at the low end of the curve and should be used if the data system has this capability.

10.7.2. Non-standard analytes are sometime requested. For these analytes, it is acceptable to analyze a single standard for pattern identification daily, rather than a five point initial calibration, provided that the client agrees with this strategy.

10.7.2.1. Positives which match the pattern of the non-standard analyte may be quantitated based on a standard reference if the elution range is similar and the client agrees to this. In this instance, “unknown hydrocarbons” are quantitated based on the default material for the fraction (e.g., diesel, motor oil, or gasoline, based on elution range).

10.7.2.2. Otherwise, a five-point initial calibration must be run and samples with positives must be reanalyzed for quantitation. If the analyte is not detected, the non-detect may be reported and no further action is necessary.

10.8. Integration

10.8.1. When evaluating the initial calibration, also evaluate hydrocarbon pattern integration.

10.8.1.1. The integration baseline should run from the point in the chromatogram prior to peaks to a region following the mixture’s peaks in a fairly straight line.

10.8.1.2. If there is unresolved material in the middle of the chromatogram, the area under the “hump” should also be integrated.

10.8.2. The default integration parameters generated as a result of evaluating the

initial calibration should remain in effect until the initial calibration is reanalyzed.

10.9. Calibration Verification (CCV)

The working calibration curve or RF must be verified by the analysis of a mid-point calibration standard at the beginning, after every 20 samples or 12 hours, whichever is more frequent, and at the end of the analysis sequence. The center of each retention time window for surrogate compounds is updated with each CCV. For fuel standards, the fuel's elution profile is compared to the initial calibration to verify that shifting has not occurred since initial calibration. If an alkane range standard has been analyzed, it is checked to verify that shifting has not occurred since the retention time windows for the fuels were set.

The mid-level calibration standard used at the start of the analysis sequence must be a different concentration than the mid-level calibration standard used for subsequent calibration verifications. Recommended concentrations are noted in Table 4.

10.9.1. It may be appropriate to analyze a mid-point standard more frequently than every 20 samples (or 12 hours, whichever is more frequent). If these continuing calibration standards are analyzed, requirements are the same.

10.9.2. The CCV must have a %D of $\leq$15% from the expected concentration for standard work. For work performed under the auspices of QSM 4.2, a %D of $\leq$20% is acceptable for the CCV. If these criterion are exceeded, then corrective actions must be implemented. Typically, samples analyzed after the nonconforming CCV are reanalyzed. However, if there is an assignable cause such as an autosampler misinjection AND the subsequent CCV meets all criteria, then the analyst may report the data and note the anomaly in the case narrative.

10.9.2.1. % Difference calculation

Equation 6

$$\% \text{ Difference} = \frac{|\text{Expected value} - \text{Calculated value}|}{\text{Expected value}} \times 100\%$$

10.9.3. It is not necessary to run a continuing calibration standard at the beginning of the sequence if samples are analyzed immediately after the completion of the initial calibration.

10.9.4. If the analyst notes that a CCV has failed and can document the reason for failure (e. g. no purge, broken vial, carryover from previous samples, etc) then a second CCV may be analyzed without any adjustments to the instrument. If this CCV meets criteria then the preceding samples have been successfully

bracketed. If adjustments to the instrument are performed before the repeat CCV then the preceding samples have not been successfully bracketed but analysis may continue.

10.9.5. In general, it is not advisable to analyze repeat CCVs on unattended runs. If repeat CCVs are analyzed the first will serve as the bracketing standard for the preceding samples and the last will serve as the CCV for the following samples.

10.9.6. If highly contaminated samples are expected it is acceptable to analyze blanks or primers at any point in the run.

10.9.7. CCV analysis for Methods AK102.0 and AK103.0 (State of Alaska) analysis includes analysis of the alkane range standard to verify retention times.

Certain programs, such as those falling under the DOD QSM, require that the alkane range standard be run daily to verify retention times.

10.10. Refer to Table 3 for details of GC operating conditions.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Extraction

The extraction procedure is described in SOP WS-OP-0004.

11.3. Cleanup

Cleanup procedures are described in WS-OP-0004.

11.4. Suggested gas chromatographic conditions are given in Table 3. Actual gas chromatographic conditions can be found in the maintenance logs.

11.5. Instrument Bleed Profile

Because the extractable hydrocarbon analysis is subject to integration difficulties as a result of column bleed and late-eluting compounds, it is advisable to subtract the

instrument bleed profile from every injection. Profiles should be renewed when there is an obvious change in the instrument's column bleed profile. Only instrument runs performed without injection of solvent and where the chromatogram shows no obvious peaks may be used for bleed profiles.

11.6. Analytical Sequence

An analytical sequence starts with an initial calibration or a calibration verification (CCV), performed as described in Sections 10.1 and 10.9.

11.6.1. If there is a break in the analytical sequence of greater than 2 hours, the sequence must be restarted with a DCM blank.

11.7. Retention Time Windows - Single Peaks

11.7.1. Retention time windows must be determined for all single peak analytes (including surrogate compounds). Make an injection of all analytes of interest each day over a three day period. Calculate the standard deviation of the three retention times for each analyte (relative retention times may also be used). Plus or minus three times the standard deviation of the retention times of each analyte defines the retention time window.

11.7.2. The center of the retention time window is the retention time from the last of the three standards. The centers of the windows for surrogate compounds are updated with the mid-point of the initial calibration and each daily calibration. The widths of the windows will remain the same until new windows are generated following the installation of a new column.

11.7.3. If the retention time window as calculated above is less than ± 0.03 minutes, use ± 0.03 minutes as the retention time window. This allows for slight variations in retention times caused by sample matrix.

11.7.4. The laboratory must calculate new retention time windows each time a new column is installed. The new windows must be generated within one week of the installation of the new column. Until these standards have been run on the new column, the retention time windows from the old column may be used, updated with the retention times from the new initial calibration.

11.7.5. The retention times of all surrogate compounds in each continuing calibration must be within the retention time windows established by the daily calibration. If this condition is not met, all samples analyzed after the last compliant standard must be reanalyzed.

11.8. Retention Time Windows - Multiple Peak Standards

Because multiple peak hydrocarbon mixtures are quantitated based on the total area between two retention times, the retention time windows that are generated are also used to determine the times used for area summing.

Retention time windows must be determined for each hydrocarbon mixture to be analyzed.

11.8.1. Make an injection of the alkane range standards once per day over a three day (72 hour) period. Calculate and tabulate the standard deviation of the three retention times for each peak in the mixture. Plus or minus three times the standard deviation of the retention times of each analyte defines the retention time window.

11.8.2. Hydrocarbon mixture summing windows are the first peak minus three times the standard deviation for that peak to the last peak plus three times the standard deviation for that peak. For example, for a fuel quantitated between n-C10 and n-C24, the peak summing window is from the retention time for n-C10 minus three times the standard deviation for n-C10 to the retention time for n-C24 plus three times the standard deviation for n-C24.

11.8.3. For mixtures which use an alkane which is not present in the carbon range reference, the retention time of the alkane may be determined by linear extrapolation, and the retention time window of the alkane following the one not present may be used to set peak summing windows. An example of this instance is JP-4 in the extractable hydrocarbons test, which uses n-C13 as the end of the summing window.

11.8.3.1. Linear Interpolation of Retention Times

Equation 7

$$RT_{Int} = RT_{Earlier} + \frac{(RT_{Later} - RT_{Earlier})}{2}$$

Where:

RT_{Int} = Interpolated Retention Time (for n-C13 in the example above)

$RT_{Earlier}$ = Retention Time of earlier peak (for n-C12 in the example above)

RT_{Later} = Retention Time of later peak (for n-C14 in the example above)

11.8.4. The center of the retention time window is the retention time from the last of the three standards. The centers of the windows for the alkane range peaks are updated with the alkane range that is run with new initial calibrations. The widths of the windows will remain the same until new windows are generated

following the installation of a new column.

11.8.4.1. Retention time windows for hydrocarbon mixtures are updated at the same time as those for the alkane peaks.

11.8.4.2. If an alkane range is not run with the initial calibration, retention times and summing windows may not be updated.

11.8.5. If the retention time window for an alkane peak as calculated above is less than ± 0.03 minutes, use ± 0.03 minutes as the retention time window.

11.8.6. The laboratory must calculate new retention time windows each time a new column is installed. The new windows must be generated within one week of the installation of the new column. Because quantitation of hydrocarbon mixtures is dependent on the peak summing window, calibration data evaluation and sample analysis cannot continue until the alkane retention time windows are established.

11.8.7. Because quantitation of fuels is based on the total area between two set retention times, each fuel standard's elution profile (peak pattern with respect to retention times denoting start and end of quantitation) in each continuing calibration must be similar to the profile at the time of initial calibration. If this condition is not met, all samples analyzed after the last compliant standard must be reanalyzed.

11.8.7.1. Compare elution profiles by utilizing the data system's capability to overlay chromatograms on-screen, and overlay the mid-level standard from the calibration curve with the daily calibration.

11.8.7.2. Alternatively, compare elution profiles by overlaying hard-copy chromatograms that are at the same scale, and comparing them.

11.8.7.3. Certain methods may require that the alkane standard be run prior to each analytical batch, and that retention times for this standard are evaluated. Such instances are detailed in the appendices.

Note: When exaggerated shifting of surrogate compounds occurs in samples, quantitation of any fuel mixture, unknown or otherwise, is likely to be adversely affected. Retention time shifting can be a result of instrument gas leaks, poor temperature control at the instrument, poor laboratory temperature control, or matrix effects. It is highly recommended that the cause is determined and samples reanalyzed when retention time shifting occurs.

12. CALCULATIONS/DATA REDUCTION

12.1. Qualitative Identification

Tentative identification occurs when a peak pattern matching the reference standard is found within the elution window for a fuel, at a concentration above the reporting limit, or above the MDL if J flags are required. If the peaks present in the chromatogram elute within the time window of the reference fuel, but the pattern does not match the reference fuel, then the material is determined to be an "Unknown Hydrocarbon" and will be reported accordingly.

12.1.1. "J" values for Unknown Hydrocarbons

Typically, unknown hydrocarbons are not reported as "J" values, or values below the reporting limit. This is because "Unknown Hydrocarbons" is a category which can both describe fuels too degraded to identify, as well as biologic by-products and other contaminants. Any quantitation of an unknown hydrocarbon is an estimate, as no true reference exists.

12.1.2. The experience of the analyst should weigh heavily in the interpretation of the chromatogram. For example, sample matrix or laboratory temperature fluctuation may result in variation of retention times.

12.2. Calibration Range

If concentrations of any analytes exceed the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (over 50% of the high level standard) of the calibration range. It may be necessary to dilute samples due to matrix.

Note: In cases of extremely oily samples, it may be advisable to dilute samples such that the analyte concentration is in the lower half of the calibration range. Such deviations should be noted and filed with the project.

12.3. Dilutions

Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

12.3.1. Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and the baseline rise is less than half the height of the peaks in the Level 3 standard, then the sample should be reanalyzed at a more concentrated dilution.

12.3.2. Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will only be reported at client request.

12.4. Interferences

If peak detection is prevented by interferences, further cleanup should be attempted. If no further cleanup is reasonable, then elevation of reporting levels and/or lack of positive identification must be addressed in the case narrative.

12.5. Calculations

Capabilities of individual data systems may require the use of different formulas than those presented here. When this is the case, the calculations used must be shown to be equivalent and must be documented in an appendix attached to this document.

12.5.1. Aqueous Samples (assuming average response factor calibration)

Equation 8

$$Concentration\ (\mu g / L) = \frac{(A_x \times V_t \times D_f)}{(CF \times V_s)}$$

Where:

A_x = Response for the analyte in the sample

D_f = Dilution factor

V_t = Volume of total extract, mL

V_s = Volume of sample extracted or purged, mL

CF = Calibration factor, area/ng/mL or area/µg/mL, Section 10.1

12.5.2. Non-aqueous Samples (assuming average response factor calibration)

Equation 9

$$\text{Concentration}(\mu g / kg) = \frac{(A_x \times V_t \times D_f)}{(CF \times W \times D)}$$

Where:

W = Weight of sample extracted or purged, g

$$D = \frac{100 - \%\text{Moisture}}{100}$$ (D = 1 if wet weight is required)

Note: The percent moisture correction may occur following entry into a LIMS database instead of at the instrument.

A_x, V_t, D_f, and CF are as defined in Equation 8

12.6. Identification of Multi-component Analytes

12.6.1. Chromatograms are evaluated only for the fuel list specified by the client. "Fingerprinting" of materials is not normally performed beyond the specified list.

12.6.2. If the material present in the client sample does not elute in a range similar to the reference(s), and the chromatographic profile is not the same, then the material is reported as an "Unknown Hydrocarbon" or similar generic title.

12.7. Evaluating Degraded Diesel #2

12.7.1. All fuels exposed to the environment are subject to a variety of weathering and degradation agents, and therefore they may not be identified after a period of time in the environment. To aid in the identification of degraded Diesel #2, four criteria should be evaluated. If at least two of the four criteria are met, but the profile is not a good match for the diesel standard, then it can be considered a degraded diesel fuel and reported as diesel fuel, with a footnote denoting that it is degraded.

12.7.2. Criteria for evaluating degraded Diesel Fuel #2

- The OTP peak (about C-19) is distinctly on the downslope of the unresolved material.
- All alkane peaks from n-C10 to n-C23 are visible.
- The envelope of unresolved material returns to the baseline between n-C23 and n-C26.
- The baseline rise for the unresolved material starts by n-C11 and the early end from n-C10 to n-C13 is present.

12.8. Surrogate recovery results are calculated and reported for Ortho-terphenyl (OTP). When this analysis is performed in support of method AK103, results for n-triacontane-d62 must also be reported. In some client specific cases, other surrogate compounds may also be used. Due to the nature of hydrocarbon fuel analysis, surrogate recovery may be elevated beyond the upper control limit as a result of area contribution from a fuel analyte. In these instances, report the recovery, and narrate the elevated recovery in the case narrative.

12.9. When reporting Diesel Range Organics (DRO), no Unknown Hydrocarbon is evaluated. If there is a concentration above the reporting limit in the DRO range, then there is DRO present.

12.10. NWTPH-Dx Reporting: "When reporting the results, the terms such as 'diesel range' or 'motor oil range', or derivations of them, should only be used when the analyst is unable to identify the petroleum product(s) present. Motor oils, hydraulic fluids, and

similar petroleum products which consist primarily of an unresolved chromatographic envelope of compounds originating at, or extending beyond tetracosane [n-C24], may be reported using the collective term 'lube oil' unless specific identification is possible. Heavy fuel oils, e.g. #6 fuel oil or Bunker-C, which contain a diesel range component as well as a lube oil range, may be reported using the collective term 'heavy fuel oil' unless specific identification is possible. Heavy fuel oils should not, however, be confused with mixtures of #2 diesel and lube oils." [Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997, Method NWTPH-Dx, page 25]

12.11. Surrogate Recovery

Concentrations of surrogate compounds are calculated using the same equations as for the target compounds. The response factor from the initial calibration is used. Surrogate recovery is calculated using the following equation:

Equation 10

$$\% \text{ Recovery} = \frac{\text{Concentration (or amount) found}}{\text{Concentration (or amount) spiked}} \times 100$$

12.12. Reporting Requirements

12.12.1. Results are reported as described in the method appendices.

12.12.2. Reporting limits are listed in the method specific appendices.

12.12.3. Significant Figures

Sample results are entered into a LIMS system in accordance with current QA policies. When reporting calculated percentages for the purposes of quality control, round to two significant digits unless the value is over 100%. If the value is over 100%, round to three significant digits.

12.12.4. The following are minimum required components of data packages submitted for approval:

- Summary of calibration factors, copy of run log, and alkane range standard chromatogram from the initial calibration (All calibration curves are retained permanently on file).
- Copies of chromatograms and reports for all continuing calibration standards associated with the project.
- Concentrations of standards indicated on raw data.
- Copy of method blank and LCS: if any parameter was out of control or data is otherwise anomalous, clear documentation of the Nonconformance should be present. Corrective actions must be

consistent with the QA plan or client specific requirements, or have approval appropriate or management approval.

- The sample prep bench sheet.
- Copy of all applicable instrument run log pages.
- Report all data in the LIMS database. It is a good idea to include preliminary datasheets with the data package if it will clarify the review process.
- All manual calculations performed must be shown on the chromatograms or quantitation report and documented in an easy-to-follow manner.
- All manual or re-integration of chromatograms must be documented in accordance with Policy CA-QS-002. Documentation includes, as a minimum, before and after copies of the chromatograms with labeling indicating the reason for re-integration

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits referenced in Table 7 (Performance limits, four replicate initial demonstration of capability).

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Autovials contaminated with methylene chloride. As the autovials are removed from the instrument after analysis, they are collected in open containers at the instrument. After the autovials are removed, the open container must be dumped into a closed satellite collection container in a fume hood, as the punctured septa in the autovial can allow methylene chloride to evaporate into the atmosphere. The satellite collection containers are transferred to the waste disposal area when full or after no more than one year, where they are disposed through the vial eater.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III, December 1996. Section 8000B

16.2. Leaking Underground Fuel Tank Field Manual, State of California, October, 1989

16.3. Underground Storage Tanks Procedures Manual, Alaska Department of Environmental Conservation, November 7, 2002; Appendix D

16.4. Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997

16.5. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW 846, 3rd Edition, Final Update III, December, 1996; Method 8015B

16.6. Alaska Department of Environmental Conservation, April 8, 2002; Methods AK102.0 and AK103.0

16.7. Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997, Method NWTPH-Dx

17. METHOD MODIFICATIONS

17.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the Method Detection Limit. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit.

17.2. The California LUFT Manual (October, 1989) recommended DHS Analytical Methods indicate that a 3 point calibration is sufficient. However, as many clients default to SW-846, this method defaults to the more stringent SW-846 criterion.

17.3. The California LUFT Manual (October, 1989) recommended DHS Analytical Methods require a 10%D criterion on continuing calibration standard. However, as many clients default to SW-846, this method defaults to the SW-846 criterion. It is believed that since this lab follows SW-846 criteria, and the DHS method is recommended, the 15%D criteria is sufficient to meet data quality objectives.

17.4. ADEC methodology specifies that standards and extracts are stored at –10 to –20°C. This SOP used 4 ± 2°C as the requirement. This temperature range is consistent with other SOPs at this facility.

17.5. NWPTH methodology specifies a linear regression curve fit which is evaluated through the correlation coefficient. This facility defaults to average response factor calibration, and evaluates it through the %RSD. Linear regression curve fits, while permitted in the SOP, are not a common occurrence.

17.6. ADEC methodology specifies a ≤ 25% RSD criterion for evaluating calibration curves. This SOP defaults to the more stringent SW846 criterion of ≤ 20% RSD.

17.7. ADEC methodology specifies a ≤ 25% difference criterion for the 12 hour calibration. This SOP defaults to the more stringent SW846 criterion of ≤ 15% difference.

18. ATTACHMENTS

18.1. Table 1 – Standard Analyte List and Reporting Limits

18.2. Table 2 – Extractable Petroleum Hydrocarbon Quantitation Ranges

18.3. Table 3 – Parameters and Recommended Conditions

18.4. Table 4 – Calibration Levels µg/mL

18.5. Table 5 – Components of Alkane Range Standard

18.6. Table 6 – LCS/Matrix Spike and Surrogate Spike Levels µg/L or mg/kg

18.7. Table 7 – Performance Limits, Four Replicate Initial Demonstration of Capability

18.8. Table 8 – AK102/103 Recovery Requirements

19. REVISION HISTORY

19.1. WS-GC-0007, Revision 5.5, Effective 09/14/2012

19.1.1. Removed Table 8 and Table 9 due to TALS implantation.

19.1.2. Remove Section 12.8 “Reporting Unknown Materials as this descriptor is not used with TALS/Chrom reporting.

19.1.3. Editorial changes

19.2. WS-GC-0007, Revision 5.4, Effective 07/15/2011

19.2.1. Modified Section 5 wording to extend the expiration of a solution used only for qualitative purposes.

19.2.2. Inserted into Table 8:

Unknown is composed mostly of a single peak.	A single unknown peak accounts for xx% of the total area for diesel (or reference reported, if not reporting diesel.

19.3. WS-GC-0007, Revision 5.3, Effective 03/25/2011

19.3.1. Editorial revisions

19.4. WS-GC-0007, Revision 5.2, Effective 03/05/2010

19.4.1. Section 7.4.2: Inserted the following sentence, “The surrogate n-triacontane-d62 is required for most AFCEE projects.”

19.4.2. Section 10.9.2: Inserted the following sentence, “For work performed under the auspices of QSM 3 and 4.1, a %D of ≤≤20% is acceptable for the CCV.”

19.4.3. Editorial revisions.

19.5. WS-GC-0007, Revision 5-1, Effective 1/16/2009

19.5.1. Changed Table 9, Last Row from:

Diesel Fuel #2 Motor Oil	Diesel Fuel #2, if n-C10 to n-C24 area > than 19-36 area. Motor Oil, if n-C19 to n-C36 area > than n-C10 to n-C24 area.	n-C08 to n-C36.

To:

Diesel Fuel #2 Motor Oil	Diesel Fuel #2, if n-C10 to n-C24 area > than 19-36 area. Motor Oil, if n-C19 to n-C36 area > than n-C10 to n-C24 area.	The segment that matches the standard used for quantitation.

19.6. WS-GC-0007, Revision 5, Effective 6/20/2008

19.6.1. Updated to TestAmerica format.

19.6.2. Minor editorial changes.

19.6.3. Updated Table 4 to reflect current Diesel and Motor Oil standard levels.

Table 1 Standard Analyte list and Reporting Limits			
Fuel	Quantitation Range	Reporting Limit, µg/L or mg/kg	
		water	soil
Diesel Fuel #2	n-C10 to n-C24	50	1.0
Additional Fuels			
Motor Oil (10W-40)	n-C19 to n-C36	250	5
JP-4	n-C8 to n-C13	50	1.0

The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Vol.	Final Vol.
Ground water	1000 mL	3 mL
Low-Level Soil	30 g	3 mL

Table 2 Extractable Petroleum Hydrocarbon Quantitation Ranges.			
Regulatory Method	Component	Quantitation Range	
EPA 8015B	Diesel Fuel	n-C10	n-C28
	Mineral Oil	n-C15	n-C40
	Mineral Spirits	n-C8	n-C13
	JP-4	n-C8	n-C13
	JP-5	n-C8	n-C16
	JP-8	n-C8	n-C18
	Hydraulic Oil	n-C20	n-C40
	Kerosene	n-C8	n-C16
	Fuel Oil #6	n-C10	n-C16
	Stoddard Solvent	n-C8	n-C13
CA-LUFT[1] (Default)	Diesel Fuel Motor Oil	n-C10 n-C19	n-C24 n-C36
NWTPH-Dx[1]	Diesel Fuel Motor Oil	n-C10 n-C19	n-C24 n-C36
AK102.0[2] AK103.03	DRO RRO	n-C10 n-C25	n-C25 n-C36

[1] *These methods specify setting the peak summing window to include any unresolved envelope of the fuel as well as all discrete peaks greater than or equal to 10% of the area of the largest peak; i.e., at the beginning and end of the fuel pattern. The Quantitation Ranges listed here meet these requirements for these fuels.*

[2] *The method specifies that the peak summing window must start at the start of the n-C10 peak and end at the start of the n-C25 peak.*

[3] *The method specifies that the peak summing window must start at the start of the n-C25 peak and end at the start of the n-C36 peak.*

Table 3	
Parameter	**Recommended Conditions**
Injection port temp	250°C
Detector temp (FID)	320°C
Injection	2µL
Injection Type/Splitter	Splitless, 0.3 min purge time, 20 mL/min purge flow
Column	DB-5.625, 30m x 0.32 mm, 0.25 µm (or equivalent)
Temperature program	50°C for 2.0 min, 15°C/min to 320°C, 3 min hold
Flow Program	5 mL/min for 2.0 min, 2 mL/min to 12 mL/min, hold to end of run
Gas Saver	On, flow = 20 mL/min
Make up gas flow mode	Makeup + column flow = constant, set for 50 mL/min
Carrier Gas	Hydrogen
Make-up Gas	Nitrogen
Fuel Gas	Hydrogen, 40 mL/min
Oxidant Gas	Air, 450 mL/min

Table 4							
Calibration Levels µg/mL							
	Level 1	Level 2	Level 3[1]	Level 4[2]	Level 5	Level 6	Level 7
Diesel Fuel	10	50	100	300	500	1000	2000
Motor Oil (10W - 40)	50	100	300	500	800	1200	1500
JP-4	10	50	100	250	500	1000	
o-terphenyl (surrogate)	1	5	10	15	20	25	
n-triacontane-d62 (surrogate)	1	5	10	15	20	25	

[1] *Designates the recommended mid-level standard concentration for the CCV at the start of an analytical sequence.*

[2] *Designates the recommended mid-level standard concentration for the CCVs following the initial CCV of a sequence.*

Table 5 Components of Alkane Range Standard[1]	
Component	Approximate Concentration (µg/mL)
n-C10 (decane)	5
n-C12 (dodecane)	5
n-C14 (tetradecane)	5
n-C16 (hexadecane)	5
n-C18 (octadecane)	5
n-C20 (cosane)	5
n-C22 (docosane)	5
n-C24 (tetracosane)	5
n-C25 (pentacosane)	5
n-C26 (hexacosane)	5
n-C28 (octacosane)	5
n-C30 (triacontane)	5
n-C32 (dotriacontane)	5
n-C34 (tetratriacontane)	5
n-C36 (hexatriacontane)	5
n-C38 (octatriacontane)	5
n-C40 (tetracontane)	5

[1] Standard is used only for setting retention times; therefore, exact concentrations are not necessary. A concentrated mixture of n-alkanes from n-C10 through n-C40 is available from Ultra Scientific. Its use is recommended.

Table 6 LCS/Matrix Spike and Surrogate Spike levels µg/L or mg/kg		
	Aqueous	Soil
Diesel Fuel	300	10
o-Terphenyl (Surrogate)	40	1.33
Motor Oil	900	30
n-Triacontane-d32	50	1.67

Table 7		
Performance limits, four replicate initial demonstration of capability		
Compound	Initial demonstration, mean recovery limits	Initial demonstration, RSD limits
Diesel Fuel	50-150	25
Motor Oil (10W - 40)	50-150	25
JP-4	50-150	25
Other Add-on Fuels	50-150	25

Table 8	
AK102/103 Recovery Requirements	
Requirement	Criteria
Surrogate recovery in samples	50-150%
Surrogate recovery in CCV	60-120%
Surrogate recovery in LCS/D	60-120%
LCS Recovery	75-120% (Diesel); 60-120% (AK-103)
LCS/LCSD RPD	Less than or equal to 20%

Title: Analysis of Samples for Polychlorinated Dioxins and Furans by HRGC/HRMS

[Methods 8290, 8290A & TO-9A]

Approvals (Signature/Date):

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1. SCOPE AND APPLICATION

1.1.1. This method provides procedures for the detection and quantitative measurement of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), polychlorinated dibenzo-p-dioxins (tetra- through octachlorinated homologs; PCDDs), and polychlorinated dibenzofurans (tetra- through octachlorinated homologs; PCDFs) in a variety of environmental matrices at part-per-trillion (ppt) concentrations by SW 846 Method 8290 and 8290A. The analytical method calls for the use of high-resolution gas chromatography and high-resolution mass spectrometry (HRGC/HRMS) on purified sample extracts. An optional method for reporting the analytical results using a 2,3,7,8-TCDD toxicity equivalency factor (TEF) is also described. Table 1 lists the various sample types covered by this analytical protocol, the 2,3,7,8-TCDD-based method calibration limits and other pertinent information.

1.2. The sensitivity of this method is dependent upon the level of interferences within a given matrix.

1.3. This method is designed for use by analysts who are experienced with residue analysis and skilled in high-resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS).

1.4. Samples containing concentrations of specific congeners (PCDDs and PCDFs) that are greater than the calibration limit should be analyzed by a protocol designed for such concentrations, such as 8280A/B.

1.5. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. This procedure uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column gas chromatography/high resolution mass spectrometry (HRGC/HRMS) techniques. Sample preparation is addressed in WS-IDP-0005.

2.2. One to two µL of the concentrated extract are injected into an HRGC/HRMS system capable of performing selected ion monitoring at resolving powers of at least 10,000 (10 percent valley definition).

2.3. The identification of ten of the 2,3,7,8-substituted congeners (Table 3), for which a ^{13}C-labeled standard is included as a spiked compound, is based on their elution at their exact retention time (-1 to +3 seconds from the respective isotope dilution analyte or internal standard signal) and simultaneous detection of the two most abundant ions in

the molecular ion region. All other identified PCDD/PCDF congeners are identified by their RRT's based on the daily CCV standard, and the simultaneous detection of the two most abundant ions in the molecular ion region. Confirmation is based on a comparison of the ratio of the integrated ion abundance of the molecular ion species to their theoretical abundance ratio.

2.4. Quantification of the individual congeners, total PCDDs and total PCDFs is achieved in conjunction with the establishment of a multipoint (five points) calibration curve for each homolog, during which each calibration solution is analyzed once.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

3.3. Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs): compounds (Figure 1) that contain from one to eight chlorine atoms. The seventeen 2,3,7,8-substituted PCDDs and PCDFs are shown in Table 3. The number of isomers at different chlorination levels is shown in Table 4.

3.4. Homologous series: Defined as a group of chlorinated dibenzodioxins or dibenzofurans having a specific number of chlorine atoms.

3.5. Isomer: Chemical compounds that contain the same number of atoms of the same elements, but differ in structural arrangement and properties. For example, 1,2,3,4-TCDD and 2,3,7,8-TCDD are different structural isomers.

3.6. Congener: Any isomer of any homologous series.

3.7. Isotope Dilution Analyte: An isotope dilution analyte is a ^{13}C-labeled analog of a congener chosen from the compounds listed in Table 3. Isotope dilution analytes are added to all samples including method blanks and quality control samples before extraction, and they are used to quantitate the concentration of the analytes. Nine isotope dilution analytes are used in this method. There is one for each of the dioxin and furan homologs (except for OCDF) with the degree of chlorination ranging from four to eight. Additional isotope dilution analytes may be added to act as retention time references, but they are not used for quantitation.

3.8. Internal Standard: Two internal standards are used to determine the percent recoveries for the isotope dilution analytes. The ^{13}C-1,2,3,4-TCDD is used to measure the percent recoveries of the tetra- and pentachlorinated isotope dilution analytes while ^{13}C-1,2,3,7,8,9-HxCDD is used to determine the recovery of the hexa-, hepta- and

octachlorinated isotope dilution analytes. ^{13}C-1,2,3,7,8,9-HxCDD also acts as a retention time reference for the unlabeled analog present in sample extracts. They are added to the final sample extract before HRGC/HRMS instrument analysis.

3.9. Estimated Detection Limit (EDL)/ Estimated Quantiation Limit (EQL): The sample specific estimated detection limit (EDL/EQL) is the concentration of a given analyte required to produce a signal with a peak height of at least 2.5 times the background noise level.

3.10. Estimated Maximum Possible Concentration (EMPC): The calculated concentration of a signal having the same retention time as a PCDD/PCDF congener, but which does not meet the other qualitative identification criteria defined in the method.

4. INTERFERENCES

4.1. Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts or elevated baselines that may cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interferents under the conditions of analysis by running laboratory method blanks. Analysts shall not use PVC gloves.

4.2. The use of high-purity reagents and solvents helps minimize interference problems. Purification of solvents by distillation in all-glass systems may be necessary.

4.3. Re-use of glassware is to be minimized to avoid the risk of contamination.

4.4. Interferents co-extracted from the sample will vary considerably from matrix to matrix. PCDDs and PCDFs are often associated with other interfering chlorinated substances such as polychlorinated biphenyls (PCBs), polychlorinated diphenyl ethers (PCDPEs), polychlorinated naphthalenes, and polychlorinated xanthenes that may be found at concentrations several orders of magnitude higher than the analytes of interest. Retention times of target analytes must be verified using reference standards. These values must correspond to the retention time windows established. While certain clean-up techniques are provided as part of this method, unique samples may require additional cleanup steps to achieve lower detection limits.

4.5. A high-resolution capillary column (60m DB-5) is used to resolve as many PCDD and PCDF isomers as possible. However, no single column is known to resolve all isomers. The DB-225 column is used for the quantitation of 2,3,7,8-TCDF when 2,3,7,8-TCDF on the DB-5 column is detected.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the Sacramento Addendum to the Corporate EH&S

Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. The effluents of sample splitters for the gas chromatograph and roughing pumps on the HRGC/HRMS system should pass through either a column of activated charcoal or be bubbled through a trap containing oil or high-boiling alcohols.

5.1.2. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex and vinyl gloves provide no protection against most of the organic solvents used in this method. Nitrile or similar gloves must be used. Latex gloves may be used for methanol.

5.1.3. Exposure to chemicals must be maintained as low as reasonably achievable, therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.4. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Iso-octane	Flammable Irritant	None established	Inhalation of vapors may cause nausea, headache, dizziness, loss of consciousness, irritation to upper respiratory tract, pain in throat and nose, coughing, wheezing, shortness of breath.
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Tetradecane	Irritant	None established	Inhalation of vapors may cause difficulty breathing, headache, intoxication and central nervous system damage.
Toluene	Flammable Poison Irritant	200 ppm-TWA 300 ppm-Ceiling	Inhalation may cause irritation of the upper respiratory tract. Symptoms of overexposure may include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e. g. pins and needles) or numbness may be produced. Causes severe eye and skin irritation with redness and pain. May be absorbed through the skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Preventive and routine maintenance is described in the 'Schedule of Routine Maintenance' in the QAM.

6.2. High-Resolution Gas Chromatograph/High-Resolution Mass Spectrometer/Data System (HRGC/HRMS/DS).

6.2.1. Capable of collecting, recording and storing MS data. The VG70 and Autospec Ultima systems utilize Opus version 3.6 software and the Autospec Premiere system utilizes MassLynx version 4.1 software.

6.2.2. The GC must be equipped for temperature programming. All required accessories must be available, such as syringes, gases, and capillary columns. The GC injection port must be designed for capillary columns. The use of splitless injection techniques is recommended. The use of a moving needle

injection port is also acceptable. When using the method described in this protocol, a 2-µL injection volume is used consistently (i.e., the injection volumes for all extracts, blanks, calibration solutions and the performance check samples are 2 µL). 1 µL injections are allowed; however, laboratories are encouraged to remain consistent throughout the analyses by using the same injection volume at all times on a given HRGC/HRMS/DS.

6.2.3. Gas Chromatograph/Mass Spectrometer (GC/MS) Interface - The GC/MS interface components should withstand 350° C. The interface must be designed so that the separation of 2,3,7,8-TCDD from the other TCDD isomers achieved in the gas chromatographic column is not appreciably degraded. Cold spots or active surfaces (adsorption sites) in the GC/MS interface can cause peak tailing and peak broadening. It is recommended that the GC column be fitted directly into the mass spectrometer ion source without being exposed to the ionizing electron beam. Graphite ferrules should be avoided in the injection port because they may adsorb the PCDDs and PCDFs. Vespel® or equivalent ferrules are recommended.

6.2.4. Mass Spectrometer - The static resolving power of the instrument must be maintained at a minimum of 10,000 (10 percent valley). The mass spectrometer must be operated in a selected ion monitoring (SIM) mode with a total cycle time (including the voltage reset time) of one second or less.

6.2.5. Data System - A dedicated data system is employed to control the rapid multiple ion monitoring process and to acquire the data. Quantification data (peak areas or peak heights) and SIM traces (displays of intensities of each ion signal being monitored including the lock-mass ion as a function of time) must be acquired during the analyses and stored. Quantifications may be reported based upon computer-generated peak areas or upon measured peak heights (chart recording). The data system must be capable of acquiring data for a minimum of 10 ions in a single scan. It is also recommended to have a data system capable of switching to different sets of ions (descriptors) at specified times during an HRGC/HRMS acquisition. The data system should be able to provide hard copies of individual ion chromatograms for selected gas chromatographic time intervals. It should also be able to acquire mass-spectral peak profiles and provide hard copies of peak profiles to demonstrate the required resolving power. The data system should also permit the measurement of noise on the base line.

6.3. GC Column

6.3.1. Due to poor separation of 2,3,7,8-TCDF from other TCDF isomers on the 60 m DB-5 column, a 30M DB-225 is used to quantitate 2,3,7,8-TCDF. This column is used when 2,3,7,8-TCDF is detected.

6.3.2. In order to have an isomer-specific determination for 2,3,7,8-TCDD and to allow the detection of OCDD/OCDF within a reasonable time interval in one HRGC/HRMS analysis, the 60-m DB-5 fused-silica capillary column is recommended. At the beginning of each 12-hour period during which samples are analyzed and after tuning, acceptable compound separation on the GC column must be demonstrated through the analysis of a column performance check solution. Operating conditions known to produce acceptable results with the recommended column are shown in Table 7.

7. REAGENTS AND STANDARDS

7.1. Solvents

7.1.1. High-purity, distilled-in-glass or highest available purity: methylene chloride, hexane, methanol, tetradecane, isooctane, toluene, and acetone.

7.2. All calibration, daily isotope dilution analyte, daily clean up internal standards, and daily spiking solutions are stable for one year from preparation. After 1 year, solutions may be re-verified. The re-verified solution may be used for an additional year, or until there is evidence of compound degradation or concentration. The re-verification must be performed using an unexpired, not previously re-verified solution from a second lot or second vendor.

7.2.1. Sealed ampules may be used until the manufacturer's expiration date is exceeded. If no expiration date is provided, then the expiration date will be 10 years from the date the ampule is opened. The solvent level should be monitored prior to each use to assure there has been no concentration of the standard over time.

7.3. Calibration Solutions

7.3.1. High-Resolution Concentration Calibration Solutions (Table 5) - Five tetradecane solutions containing unlabeled (totaling 17) and carbon-labeled (totaling 16) PCDDs and PCDFs at known concentrations are used to calibrate the instrument. The concentration ranges are homolog dependent, with the lowest values associated with the tetra chlorinated dioxins and furans (0.5 pg/µL) and the highest for the octachlorinated congeners (2000 pg/µL).

7.3.2. Individual isomers that make up the high-resolution concentration calibration solutions are obtained from commercial sources and prepared in the laboratory. These standards are traceable back to EPA-supplied standard solutions.

7.3.3. Store the calibration solutions in appropriate containers and at room temperature in the dark.

7.3.4. Standards for method 8290A require storage at ≤ 6°C.

7.4. GC Column Performance Check Solution

7.4.1. This solution contains the first and last eluting isomers for each homologous series from tetra- through hepta-chlorinated congeners. The solution also contains a series of other TCDD isomers for the purpose of documenting the chromatographic resolution. The ^{13}C-2,3,7,8-TCDD is also present. The laboratory is required to use tetradecane as the solvent and adjust the volume so that the final concentration does not exceed 100 pg/µL per congener. Table 8 summarizes the qualitative composition (minimum requirement) of this performance evaluation solution for the DB-5 column.

7.4.2. For the DB-225 column, the column performance check solution contains a series of TCDF isomers in addition to the 2,3,7,8-TCDF. The solution is injected and evaluated at the start of each analytical sequence on the DB-225 column to ensure that 2,3,7,8-TCDF is resolved from its closest eluting isomers with a baseline-to-valley ratio of ≤ 25%. Table 8 summarizes the qualitative composition (minimum requirement) of this performance evaluation solution on for the DB-225 column.

7.5. Field Surrogate Solution (air matrices)

7.5.1. This solution contains one ^{37}Cl labeled analog (for Method TO-9/TO-9A) or one ^{37}Cl and four ^{13}C labeled analogs (for Methods 23 and/or 0023A) at the nominal concentration indicated in Table 2. It is used to assess sample collection and recovery procedures.

7.6. Sample Fortification Solution (Isotope dilution analyte)

7.6.1. This isooctane (or toluene) solution contains the nine isotope dilution analytes at the nominal concentrations that are listed in Table 2. The solution contains at least one carbon-labeled standard for each homologous series, and it is used to measure the concentrations of the native substances. (Note that ^{13}C-OCDF is not present in the solution.)

7.7. Internal Standard Solution

7.7.1. This tetradecane solution contains two internal standards (^{13}C-1,2,3,4-TCDD and ^{13}C-1,2,3,7,8,9-HxCDD). An appropriate volume of this solution will be spiked into each sample extract before the final concentration step and HRGC/HRMS analysis.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. The sample collection, shipping, handling, and chain-of-custody procedures are not described in this document. Sample collection personnel will, to the extent possible, homogenize samples in the field before filling the sample containers. This should minimize or eliminate the necessity for sample homogenization in the laboratory. The analyst should make a judgment, based on the appearance of the sample, regarding the necessity for additional mixing. If the sample is clearly non-homogeneous, the entire contents should be transferred to a glass or stainless steel pan for mixing with a stainless steel spoon or spatula before removal of a sample portion for analysis.

8.2. Grab and composite samples must be collected in glass containers.

8.3. Ambient air samples are collected on a Quartz Fiber Filter followed by a glass sleeve containing a polyurethane foam plug.

8.4. Samples from stationary sources are collected on glass or quartz fiber filters and XAD-2 Resin. (See WS-ID-0009 for sample preparation procedures).

8.5. Conventional sampling practices must be followed. Do not rinse the bottle with sample before collection. Sampling equipment must be free of potential sources of contamination.

8.6. With the exception of the fish tissues, which must be stored at - 20°C, all samples should be stored at 4°C ± 2, extracted within 30 days and completely analyzed within 45 days of collection. The 30 day hold time is recommended. PCDDs and PCDFs have demonstrated stability for greater than one year.

8.7. All extracts must be stored capped, in the dark, at room temperature (approximately 21°C to 28°C). All extracts for method 8290A must be stored capped at $\leq 6^{o}$C.

9. QUALITY CONTROL

9.1. One method blank (MB) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The method blank is an aliquot of laboratory matrix (reagent water, Ottawa sand, sodium sulfate, PUF, XAD, filter, etc.) processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when target analytes are detected in the method blank above the reporting limit or when surrogate recoveries are outside control limits. Re-extraction of the blank, other batch QC, and the affected samples are required when the method blank is deemed unacceptable. The method blank contains a PUF plug, XAD, or filter prepared from the same batch as the field samples whenever possible for air samples.

Certain programs, such as DOD, may require a more stringent evaluation of the method blank, for instance, that the blank not contain any analytes of interest at a concentration greater than ½ the lower calibration limit.

Note: Re-extraction of the blank, QC and affected samples for the air matrices (PUF, XAD, and filter) is not generally possible because the entire sample is consumed in the initial extraction.

9.1.1. The method blank must be spiked prior to extraction with the same amount of ^{13}C-labeled isotope dilution analytes as added to samples.

9.1.2. If method blank contamination is present, check solvents, reagents, fortification solutions, apparatus and glassware to locate and eliminate the source of contamination before any further samples are extracted and analyzed.

9.1.2.1. OCDD is a ubiquitous laboratory contaminant. A method blank and the associated samples are deemed acceptable if the OCDD concentration is <5x the specified reporting limit. Flag data appropriately. The analyst is expected to investigate and eliminate potential sources of systematic contamination.

9.1.2.2. If a target analyte is detected in the blank but the associated samples are ND (not detected), then the data may be reported, unless otherwise directed by the client. Note the action in the narrative.

9.1.2.3. If a target analyte is detected in the blank, but the concentration of the contaminant in the samples >10x the blank concentration, then the data may be reported, unless otherwise directed by the client. Note the action in the narrative.

9.1.3. If new batches of reagents or solvents contain interfering contaminants, purify or discard them.

9.2. A Laboratory Control Sample (LCS) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water, Ottawa sand, sodium sulfate, PUF, XAD, etc.) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte is outside control limits provided on the LIMS or by the client. Re-extraction of the blank, other batch QC and all associated samples are required if the LCS is deemed unacceptable. See policy WS-PQA-003 for specific acceptance criteria. When associated with PUF samples, the LCS should contain a PUF plug prepared from the same batch as the field samples whenever possible.

Note: Re-extraction of the blank, QC and affected samples for the air matrices (PUF, XAD, and filter) is not generally possible because the entire sample is consumed in the initial extraction.

9.2.1. A LCS is deemed acceptable if control analytes are above upper control limits and the associated samples are ND, unless otherwise specified by the client. Note any actions in the narrative.

9.3. The assessment of matrix effects on method performance, as required by NELAP, is met in Method 8290 and 8290A, as in all isotope dilution techniques, with the use of isotopically labeled compounds. These isotopically labeled compounds are analogs of target analytes and are spiked into each sample. Therefore, matrix effects on method performance may be judged by the recovery of these analogs. Sample analysis acceptance is controlled by the performance of these analogs in each sample. A Matrix Spike/Matrix Spike Duplicate (MS/MSD or MS/SD) pair are extracted at the client's request only. Method 8290A does not address analysis of MS/MSD. An exception to this rule is a batch containing South Carolina samples for Method 8290. These batches must have an MS/MSD prepared. However, South Carolina requires Method 8290A after December 31, 2008. An MS/MSD pair are aliquots of a selected field sample spiked with analytes of known identity and concentration. When requested by the client, the MS/MSD pair shall be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spike analyte is outside control limits provided on the LIMS or by the client. Re-extraction of the blank, the LCS, the selected field sample, and the MS/MSD may be required after evaluation and review. Matrix Spike/ Matrix Spike Duplicates are not generally applicable for air samples due to the difficulty in collecting identical or representative samples. An LCS/LCSD may be extracted to show precision of the extraction and analysis process.

9.3.1. Matrix Spike (MS): A sample, which is spiked with a known amount of the matrix spike fortification solution prior to the extraction step. The recoveries of the matrix spike compounds are determined; they are used to estimate the effect of the sample matrix upon the analytical methodology.

9.3.2. Matrix Spike Duplicate (MSD): A second portion of the same sample as used in the matrix spike analysis and which is treated like the matrix spike sample.

9.3.3. Locate the sample for the MS and MSD analyses (the sample may be labeled "double volume").

9.3.4. Add an appropriate volume of the matrix spike fortification solution, adjusting the fortification level as specified in Table 1, under IS Spiking Levels.

9.3.5. Analyze the MS and MSD samples as described in Section 11.

9.3.6. The results obtained from the MS and MSD samples (percent recovery and concentrations of 2,3,7,8-substituted PCDDs/PCDFs) should agree within 20 percent relative difference. Report all results and flag outliers.

9.3.7. Isotope dilution analyte recoveries are flagged if they are outside the recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any isotope dilution analyte is less than 10:1.

9.4. Duplicates

9.4.1. Upon client request, duplicates may be processed. Locate the sample specified for duplicate analysis, and prepare and analyze a second 10-g soil or sediment sample portion or 1-L water sample, or an appropriate amount of the type of matrix under consideration. Duplicate samples are not generally applicable for air samples due to the difficulty in collecting identical or representative samples. A duplicate injection of a sample extract may be performed to display instrument precision.

9.4.1.1. The results of the laboratory duplicates (percent recovery and concentrations of 2,3,7,8-substituted PCDD/PCDF compounds) should agree within 25 percent relative difference. Report all results and flag outliers.

9.4.2. Isotope dilution analyte recoveries are flagged if they are outside the recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any isotope dilution analyte is less than 10:1.

9.5. Surrogate/Clean Up Internal Standard

A surrogate compound may be spiked into all air media samples prior to collection. For all other matrices, a clean up internal standard is spiked following extraction and just prior to cleanup, in order to monitor relative loss of isotope dilution analyte during both extraction and cleanup.

9.6. Isotope Dilution Analytes

9.6.1. Isotope dilution analytes must be spiked into all samples, QC samples, and included in all calibrations.

9.6.2. For each sample and QC aliquot, calculate the percent recovery. The percent recovery should be between 40 percent and 135 percent for all nine isotope dilution analytes.

9.6.3. A low or high percent recovery for a blank does not require discarding the analytical data but it may indicate a potential problem with future analytical data. Isotope dilution analyte recoveries are flagged if they are outside the

recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any isotope dilution analyte is less than 10:1.

9.7. Recommended Corrective Actions and Troubleshooting Steps

- Verify satisfactory instrument performance.
- If possible, verify that no error was made while weighing the sample portions.
- Review the analytical procedures with the performing laboratory personnel.

10. CALIBRATION

Calibration and Standardization requires a check of mass resolution (tuning), a check of chromatographic resolution, a verification of switching times (i.e. descriptors), and a calibration curve verification.

10.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)".

10.2. Tuning (Mass Resolution Check)

10.2.1. The mass spectrometer must be operated in the electron ionization mode. A static resolving power of at least 10,000 (10 percent valley definition) must be demonstrated at appropriate masses before any analysis is performed. Corrective actions must be implemented whenever the resolving power does not meet the requirement.

10.2.2. Chromatography time for PCDDs and PCDFs exceeds the long-term mass stability of the mass spectrometer. Because the instrument is operated in the high-resolution mode, mass drifts of a few ppm (e.g., 5 ppm in mass) can have serious adverse effects on instrument performance. Therefore, a mass-drift correction is mandatory. To that effect, it is recommended to select a lock-mass ion from the reference compound (PFK is recommended) used for tuning the mass spectrometer. The selection of the lock-mass ion is dependent on the masses of the ions monitored within each descriptor. Table 6 offers some suggestions for the lock-mass ions. However, an acceptable lock-mass ion at any mass between the lightest and heaviest ion in each descriptor can be used to monitor and correct mass drifts. The level of the reference compound (PFK) metered into the ion chamber during HRGC/HRMS analyses should be adjusted so that the amplitude of the most intense selected lock-mass ion signal (regardless of the descriptor number) does not exceed 10 percent of the full-scale deflection for a given set of detector parameters. Under those conditions, sensitivity changes that might occur during the analysis can be more effectively monitored.

NOTE: Excessive PFK (or any other reference substance) may cause noise problems and contamination of the ion source resulting in downtime for source cleaning.

10.2.3. By using a PFK molecular leak, tune the instrument to meet minimum required resolving power of 10,000 (10 percent valley) at m/z 304.9824 (PFK) or any other reference signal close to m/z 303.9016 (from TCDF). Verify that the exact mass of m/z 380.9760 (PFK) is within 5 ppm of the required value. Note that the selection of the low- and high-mass ions must be such that they provide the largest voltage jump performed in any of the five mass descriptors (Table 6).

10.2.4. Documentation of the instrument resolving power must then be accomplished by recording the peak profile of the high-mass reference signal (m/z 380.9760). The minimum resolving power of 10,000 must be demonstrated on the high-mass ion while it is transmitted at a lower accelerating voltage than the low-mass reference ion, which is transmitted at full sensitivity. The format of the peak profile representation (Figure 3) must allow manual determination of the resolution, i.e., the horizontal axis must be a calibrated mass scale (amu or ppm per division). The result of the peak width measurement (performed at 5 percent of the maximum, which corresponds to the 10-percent valley definition) must appear on the hard copy and cannot exceed 100 ppm at m/z 380.9760 (or 0.038 amu at that particular mass).

10.3. Performance Checks

10.3.1. At the beginning of each 12-hour period during which samples are to be analyzed, aliquots of the 1) GC column performance check solution and 2) high-resolution concentration calibration solution No. 4 (HRCC-4) shall be analyzed to demonstrate adequate GC resolution and sensitivity, response factor reproducibility, and mass range calibration, and to establish the PCDD/PCDF retention time windows. (Note: A HRCC-3 or HRCC-5 may be acquired to meet the requirement of #2 above. This is to provide documentation of consistency for varying concentration levels, and to meet NELAC requirements). A mass resolution check shall also be performed to demonstrate adequate mass resolution using an appropriate reference compound (PFK is recommended). If the required criteria are not met, remedial action must be taken before any samples are analyzed. The mass resolution check will be taken at the beginning and completion of an analytical sequence. An analytical sequence may contain one or more 12 hour periods.

10.3.1.1. Method blanks or solvent blanks are used to demonstrate that the analytical system is free of contamination after the analysis of calibration standards or high level samples. The blank must demonstrate that the system has returned to appropriate background levels prior to continued analysis.

10.3.2. At a minimum, the ions listed in Table 6 for each of the five SIM descriptors

must be monitored. Note that the PeCDF masses (M+2 & M+4) are also monitored in the first descriptor. This is because the first PeCDF isomer elutes closely to the final tetra isomer. The selection (Table 6) of the molecular ions M and M+2 for ^{13}C-HxCDF and ^{13}C-HpCDF rather than M+2 and M+4 (for consistency) is to eliminate, even under high-resolution mass spectrometric conditions, interferences occurring in these two ion channels for samples containing high levels of native HxCDDs and HpCDDs. It is important to maintain the same set of ions for both calibration and sample extract analyses. The recommended mass spectrometer tuning conditions are based on the groups of monitored ions shown in Table 6.

10.3.2.1. The GC column performance check mixture, high-resolution concentration calibration solutions, and the sample fortification solutions may be obtained from the EMSL-CIN. However, if not available from the EMSL-CIN, standards can be obtained from other sources, and solutions can be prepared in the laboratory. Concentrations of all solutions containing 2,3,7,8-substituted native PCDDs/PCDFs, must be verified by comparison with second-source standard solutions.

10.4. Initial Calibration

Initial calibration is required before any samples are analyzed for PCDDs and PCDFs. Initial calibration is also required if any routine calibration (Section 10.5) does not meet the required criteria listed in Section 10.6.

10.4.1. Five high-resolution concentration calibration solutions, listed in Table 5, must be used for the initial calibration.

10.4.2. Tune the instrument with PFK.

10.4.3. Inject 1 or 2 µL of the GC column performance check solution and acquire SIM mass spectral data as described earlier in Section 6.1.3. The total cycle time must be ≤ 1 second. This is analyzed prior to a calibration curve to set descriptor windows only and may not otherwise be documented. The laboratory must not analyze samples until it is demonstrated and documented that the criterion listed in Section 13.1 is met.

10.4.3.1. Select the injection volume based upon the expected target analyte concentration, or expected matrix interferences.

10.4.3.2. The same injection volume must be used for all samples, QC, and standards.

10.4.4. By using the same GC and mass spectrometer conditions that produced acceptable results with the column performance check solution, analyze a 1 or

2-µL portion of each of the five concentration calibration solutions once with the following mass spectrometer operating parameter.

10.4.4.1. The total cycle time for data acquisition must be < 1 second. The total cycle time includes the sum of all dwell times and voltage reset times.

10.4.4.2. Acquire SIM data for all the ions listed in the five descriptors of Table 6.

10.4.4.3. The ratio of integrated ion current for the ions appearing in Table 9 (homologous series quantification ions) must be within the indicated control limits (set for each homologous series).

10.4.4.4. The ratio of integrated ion current for the ions belonging to the ^{13}C labeled isotope dilution analytes and internal standards must be within the control limits stipulated in Table 9.

NOTE: Section 10.4.3 requires that ion ratios be within the specified control limits simultaneously in one run. It is the laboratory's responsibility to take corrective action if the ion abundance ratios are outside the limits.

10.4.5. For each SICP and for each GC signal corresponding to the elution of a target analyte and of its labeled standards, the signal-to-noise ratio (S/N) must be better than or equal to 10. This measurement is suggested for any GC peak that has an apparent S/N of less than 5:1. The result of the calculation must appear on the SICP above the GC peak in question.

10.4.5.1. Referring to Table 5, calculate the 17 relative response factors (RRF) for unlabeled target analytes [RRF(n); n=1 to 17] relative to their appropriate isotope dilution analytes (Table 5) and the nine RRFs for the labeled ^{13}C isotope dilution analytes [RRF(m); m=18 to 26] relative to the two internal standards according to the following formulae:

$$RRF(n) = \frac{A_x \times Q_{IDA}}{Q_x \times A_{IDA}} \qquad RRF(m) = \frac{A_{IDA} \times Q_{IS}}{Q_{IDA} \times A_{IS}}$$

Where:

A_x = sum of the integrated ion abundances of the quantitation ions (Tables 6 and 5) for unlabeled PCDDs/PCDFs,

A_{IDA} = sum of the integrated ion abundances of the quantitation ions (Tables 6 and 5) for the labeled isotope dilution analytes,

A_{IS} = sum of the integrated ion abundances of the quantitation ions (Tables 6 and 10) for the labeled internal standards,

Q_{IDA} = quantity of the isotope dilution analyte injected (pg),

Q_{IS} = quantity of the internal standard injected (pg), and

Q_x = quantity of the unlabeled PCDD/PCDF analyte injected (pg).

The RRF (n) and RRF (m) are dimensionless quantities; the units used to express Q_{IDA}, Q_{IS}, and Qx must be the same.

10.4.5.2. Calculate the RRF(n)s and their respective percent relative standard deviations (%RSD) for the five calibration solutions:

$$\overline{RRF}(n) = (1/5)\sum_{j=1}^{5} RRF_j(n)$$

Where n represents a particular PCDD/PCDF (2,3,7,8-substituted) congener (n = 1 to 17; Table 5), and j is the injection number (or calibration solution number; j = 1 to 5).

10.4.5.3. The relative response factors to be used for the determination of the concentration of total isomers in a homologous series are calculated as follows:

10.4.5.3.1. For congeners that belong to a homologous series containing only one isomer (e.g., OCDD and OCDF) or only one 2,3,7,8-substituted isomer (Table 4; TCDD, PeCDD, HpCDD, and TCDF), the mean RRF used will be the same as the mean RRF determined in Section 10.3.5.2.

NOTE: The calibration solutions do not contain ^{13}C-OCDF as an isotope dilution analyte. This is because a minimum resolving power of 12,000 is required to resolve the [M+6]+ ion of ^{13}C-OCDF from the [M+2]+ ion of OCDD (and [M+4]+ from ^{13}C-OCDF with [M]+ of OCDD). Therefore, the RRF for OCDF is calculated relative to ^{13}C-OCDD.

10.4.5.3.2. For congeners that belong to a homologous series containing more than one 2,3,7,8-substituted isomer (Table 4), the mean RRF used for those homologous series will be the mean of the RRFs calculated for all individual 2,3,7,8-substituted congeners using the equation below:

$$\overline{RRF}(k) = (1/t)\sum_{n=1}^{t} RRF_n$$

Where:

k = 27 to 30, with 27 = PeCDF;

28 = HxCDF; 29 = HxCDD; and 30 = HpCDF,

t = total number of 2,3,7,8-substituted isomers present in the calibration solutions (Table 5) for each homologous series (e.g., two for PeCDF, four for HxCDF, three for HxCDD, two for HpCDF).

NOTE: Presumably, the HRGC/HRMS response factors of different isomers within a homologous series are different. However, this analytical protocol will make the assumption that the HRGC/HRMS responses of all isomers in a homologous series that do not have the 2,3,7,8-substitution patterns are the same as the responses of one or more of the 2,3,7,8-substituted isomer(s) in that homologous series.

10.4.5.4. Relative response factors [RRF(m)] to be used for the determination of the percent recoveries for the nine isotope dilution analytes are calculated as follows:

$$RRF(m) = \frac{A_{IDA}^{m} \times Q_{IS}}{Q_{IDA}^{m} \times A_{IS}}$$

$$\overline{RRF}(m) = (1/5)\sum_{j=1}^{5} RRF_j(m)$$

Where:

m = 18 to 26 (congener type)

j = 1 to 5 (injection number),

A_{IDA}^{m} = sum of the integrated ion abundances of the quantitation ions (Tables 6 and 10) for a given isotope dilution analyte (m = 18 to 26),

A_{IDA} = sum of the integrated ion abundances of the quantitation ions (Tables 6 and 10) for a given isotope dilution analyte (m = 18 to 26),

Q_{IDA} & Q_{IDA}^{m} = quantities of, respectively, the internal standard (rs) and a particular isotope dilution analyte (m) injected (pg),

RRF(m) = relative response factor of a particular isotope dilution analyte (m) relative to an appropriate internal standard, as determined from one injection, and

$\overline{RRF(m)}$ = calculated mean relative response factor of a particular isotope dilution analyte, as determined from the five initial calibration injections (j).

10.5. Criteria for acceptable calibration

The criteria listed below for acceptable calibration must be met before sample analysis is performed.

10.5.1. The percent relative standard deviations for the mean response factors [RRF(n) and RRF(m)] from the 17 unlabeled standards must be ≤ 20 percent, and those for the nine labeled reference compounds must be ≤ 30 percent.

Note: If Method 8290A criteria are required for the project then both the percent standard relative standard deviation for the mean response factors for the 17 unlabeled standards and the nine labeled reference compounds must be ≤ 20 percent.

10.5.2. The signal/noise ratio (S/N) for the GC signals present in every SICP (including the ones for the labeled standards) must be ≥ 10.

10.5.3. The isotopic ratios (Table 9) must be within the specified control limits.

NOTE: If the criterion for acceptable calibration listed in Section 10.4.1 is met, the analyte-specific RRF can then be considered independent of the analyte quantity for the calibration concentration range. The mean RRFs will be used for all calculations until the routine calibration criteria (Section 10.6) are no longer met. At such time, new mean RRFs will be calculated from a new set of injections of the calibration solutions.

10.6. Routine Calibration (continuing calibration check)

Routine calibrations must be performed at the beginning of (following a successful tune and GC column performance check) and after a 12 hour period. The routine calibration initiates the 12 hour clock during which samples may be subsequently analyzed. The last sample in the sequence must be injected within 12 hours of the routine calibration, followed by the analysis of a closing calibration check. An acceptable closing calibration check standard may be used to initiate the next 12 hour analysis sequence when consecutive acquisition sequences occur. The ending mass resolution check shall be performed after the closing calibration check of an analysis acquisition sequence or after the final bracketing standard when consecutive 12 hour acquisition sequences are run.

10.6.1. Inject 1 or 2 µL of the concentration calibration solution HRCC-4 containing 10 pg/µL of tetrachlorinated congeners, 50 pg/µL of penta-, hexa-, and heptachlorinated congeners, 100 pg/µL of octachlorinated congeners, and the respective isotope dilution analyte and internal standards (Table 5). By using the same HRGC/HRMS conditions as used in Sections 6.1.3 through 6.2, determine and document an acceptable calibration as provided in Section 10.6.

10.7. Criteria for Acceptable Routine Calibration

The following criteria must be met before further analysis is performed. If these criteria are not met, corrective action must be taken, including recalibration if needed.

10.7.1. The measured RRFs [RRF(n)] for the unlabeled standards obtained during the opening continuing calibration must be ± 20 percent of the mean values established during the initial calibration (Section 10.3.5.)

10.7.1.1. The bracketing continuing calibration must be ± 20% of the average RRF calculated from the initial calibration.

10.7.1.1.1. If the target compounds in the ending standard are less than or equal to ± 20% of the average RRF from the initial calibration, the RRFs of the initial calibration shall be used to quantitate the unlabeled isomers.

10.7.1.1.2. If the target analytes are greater than ± 20% but less or equal to ±25% and the samples are non-detect, the data is acceptable and this anomaly is documented. If these isomers are greater than ± 20% but less or equal to ±25% and are positive, an average RRF of the initial and ending daily standard is calculated and used to quantitate the concentration of the affected congener, and the anomaly is documented.

10.7.1.1.3. If the percent deviation of unlabeled compounds exceeds ± 25%, a new initial calibration is initiated within 2 hours following the analysis of the samples. Otherwise, reanalyze all sample extracts with positives for the failed target compounds.

10.7.2. The measured RRFs [RRF(m)] for the labeled standards obtained during the opening continuing calibration must be less than or equal to ± 30 percent of the mean values established during the initial calibration (Section 10.1.5).

10.7.2.1. The bracketing continuing calibration must be ± 30% of the average RRF calculated from the initial calibration.

10.7.2.1.1. If the labelled compounds in the ending standard are less than or equal to ±30% of the average RRF from the initial calibration, the RRFs of the initial calibration shall be used to quantitate the labeled isomers.

10.7.2.1.2. If the isotope dilution analyte analytes are greater than ± 30% but less or equal to ±35%, an average RRF of the initial and ending daily standards is calculated and used to quantitate the concentration of the affected congener.

10.7.2.1.3. If the percent deviation of labeled compounds exceeds ± 35%, reanalyze samples if adversely impacted.

10.7.3. The ion-abundance ratios (Table 9) must be within the allowed control limits.

10.7.4. If either criteria in Sections 10.7.1 or 10.7.2 are not met, additional samples may not be analyzed. Sample data collected must be evaluated for usability. Narrate any reported data from the analytical sequence. If the ion-abundance ratio criterion is not satisfied, refer to the note in Section 10.4.3 for resolution.

10.7.5. If the above criteria (Section 10.7) cannot be satisfied, the entire initial calibration process (Section 10.4) must be repeated.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Sample Dilution Procedure – Simple Dilutions

Dilutions from 2X to 50X can be achieved without respiking the final extract. The calculation to determine the final extract concentration is as follows:

(Concentration of the original extract) x (amount of aliquot taken) x (volume of diluted extract) = final concentration of dilution.

Ex: 50X dilution of original 10 g/20 µL sample

(10 g/20 µL) x (2 µL aliquot + 98 µL keeper) = 1 g/100 µL FV

Record the final sample concentration on the extract label.

11.3. Sample Dilution Procedure – Complex Dilutions

Complex dilution requiring respiking of IDA and IS: Dilutions greater than 50x must be done by diluting and respiking the extract with IDA's and IS. This procedure may require serial dilution to be performed. If this procedure is done, then the sample size must be adjusted to reflect the aliquot taken.

Ex. 100X dilution (original sample with 10 g/20 µL final volume)

Take a 2 µL aliquot (1/10 of original sample) and add 18 µL of solvent keeper. Take a 2 µL aliquot of the dilution (1/100 of the original sample), respike with 1 mL IDA and 20 µL IS, reduced to 20 µL FV.

Record the final sample concentration of the extract label.

11.4. Analytical Procedures

11.4.1. Inject a 1 or 2 µL aliquot of the extract into the GC, operated under the conditions previously used (Section 6.2) to produce acceptable results with the performance check solution.

11.4.2. Acquire SIM data according to Section 6.1.3. Use the same acquisition and mass spectrometer operating conditions previously used to determine the relative response factors (Section 10). Ions characteristic for polychlorinated diphenyl ethers are included in the descriptors listed in Table 6. Their presence is used to monitor their interference during the characterization of PCDFs.

12. CALCULATIONS/DATA REDUCTION

12.1. Identification Criteria

For a gas chromatographic peak to be identified as a PCDD or PCDF, it must meet all of the following criteria:

12.1.1. Retention Times

12.1.1.1. For 2,3,7,8-substituted congeners, which have an isotopically labeled isotope dilution analyte or internal standard present in the sample extract, the retention time (at maximum peak height) of the sample components (i.e., the two ions used for quantitation purposes listed in Table 6) must be within -1 and +3 seconds of the retention time of the peak for the isotopically labeled isotope dilution analyte or internal standard at m/z corresponding to the first characteristic ion (of the set of two; Table 6) to obtain a positive identification of these nine 2,3,7,8-substituted PCDDs/PCDFs and OCDD.

12.1.1.2. For 2,3,7,8-substituted compounds that do not have an isotopically labeled isotope dilution analyte present in the sample extract, the relative retention time (relative to the appropriate isotope dilution analyte) must fall within 0.005 relative retention time units of the relative retention times measured in the daily routine calibration. Identification of OCDF is based on its retention time relative to ^{13}C-OCDD as determined from the daily routine calibration results.

12.1.1.3. For non-2,3,7,8-substituted compounds (tetra through octa; totaling 119 congeners), the retention time must be within the corresponding homologous retention time windows established by analyzing the column performance check solution.

12.1.1.4. The ion current responses for both ions used for quantitative purposes (e.g., for TCDDs: m/z 319.8965 and 321.8936) must reach a maximum simultaneously (± 2 seconds).

12.1.1.5. The ion current responses for both ions used for the labeled standards (e.g., for ^{13}C-TCDD: m/z 331.9368 and m/z 333.9339) must reach a maximum simultaneously (± 2 seconds).

12.1.2. Ion Abundance Ratios

The integrated ion current for the two ions used for quantitation purposes must have a ratio between the lower and upper limits established for the homologous series to which the peak is assigned. See Table 9.

12.1.3. Signal-To-Noise Ratio

All ion current intensities must be >2.5 times noise level for positive identification of the PCDD/PCDF compound or a group of coeluting isomers. Figure 4 describes the procedure to be followed for the determination of the S/N.

12.1.4. Polychlorinated Diphenyl Ether Interferences

In addition to the above criteria, the identification of a GC peak as a PCDF can only be made if no signal having a S/N >2.5 is detected, at the same retention time (± 2 seconds), in the corresponding polychlorinated diphenyl ether (PCDPE, Table 6) channel.

12.2. For gas chromatographic peaks that have met the criteria outlined above, calculate the concentration of the PCDD or PCDF compounds using the formula:

$$C_x = \frac{A_x \times Q_{IDA}}{A_{IDA} \times W \times RRF(n)}$$

Where:

C_x = concentration of unlabeled PCDD/PCDF congeners (or group of coeluting isomers within an homologous series) usually in pg/g or pg/L,

Ax = sum of the integrated ion abundances of the quantitation ions (Table 6) for the unlabeled PCDD/PCDFs,

A_{IDA} = sum of the integrated ion abundances of the quantitation ions (Table 6) for the labeled isotope dilution analytes,

Q_{IDA} = quantity, in pg, of the isotope dilution analyte added to the sample before extraction,

W = sample size in g (if solid) or L (if liquid).

$RRF(n)$ = Calculated mean relative response factor for the analyte [RRF(n) with n = 1 to 17; Section 10.3.5].

If the analyte is identified as one of the 2,3,7,8-substituted PCDDs or PCDFs, RRF(n) is the value calculated using the equation in Section 10.3.5.1. However, if it is a non-2,3,7,8-substituted congener, the RRF(k) value is the one calculated using the equation in Section 10.3.5.3.2 [RRF(k) with k = 27 to 30].

12.3. Calculate the percent recovery of the nine isotope dilution analytes measured in the sample extract, using the formula:

$$\text{Isotope Dilution Analytes Percent Recovery} = \frac{A_{IDA} \times Q_{IS}}{Q_{IDA} \times A_{IS} \times RRF(m)} \times 100$$

Where:

A_{IDA} = sum of the integrated ion abundances of the quantitation ions (Table 6) for the labeled isotope dilution analytes,

A_{IS} = sum of the integrated ion abundances of the quantitation ions (Table 6) for the labeled internal standard; the selection of the internal standard depends on the type of congeners (see Table 5, footnotes),

Q_{IDA} = Quantity, in pg, of the isotope dilution analyte added to the sample before extraction,

Q_{IS} = Quantity, in pg, of the internal standard added to the cleaned-up sample residue before HRGC/HRMS analysis, and

$RRF(m)$ = calculated mean relative response factor for the labeled isotope dilution analyte relative to the appropriate (see Table 5, footnotes) internal standard. This represents the mean obtained in Section 10.3.5.4 [RRF(m) with m = 18 to 26].

12.4. If the concentration in the final extract of any of the fifteen 2,3,7,8-substituted PCDD/PCDF compounds (Table 3) exceeds the upper method calibration limit (MCL) for that compound listed in Table 1, the linear range of response versus concentration may have been exceeded. In such cases, the following corrective actions will be undertaken:

12.4.1. If the signal for the analyte has saturated the detector, a single dilution and reanalysis of the extract will be made in an attempt to bring the signal within the range of the detector. If the measured concentration of the analyte is still above the MCL, the reported concentration for the analyte will be qualified appropriately. Some programs, such as DOD QSM, require all compounds to be within the linear calibration range in which a serial dilution must be performed to achieve acceptable quantitation.

12.4.2. If the signal for the analyte is above the MCL but does not saturate the detector, the concentration will be reported and qualified appropriately. Some programs, such as DOD QSM, require all compounds to be within the linear calibration range in which a serial dilution must be performed to achieve acceptable quantitation.

12.5. In either case, **with the approval of the client**, the sample may be re-extracted and/or re-analyzed with one or more of the following adjustments made to the analytical procedure in order to provide a concentration which meets client-specific data quality objectives.

12.5.1. Extraction and analysis of a one tenth aliquot. This is appropriate if it will provide analyte concentration within the MCL and a representative sample aliquot.

12.5.2. Extraction of an aliquot large enough to be representative with an increased concentration of isotope dilution analyte and surrogate spike components added prior to the extraction. The extract is then diluted either prior to or after the cleanup procedures.

12.5.3. Dilution of the original extract. Isotope dilution analyte components are re-spiked at an appropriate level prior to analysis. In this case, the isotope dilution analyte recoveries are taken from the original analysis.

12.6. For the other congeners (including OCDD and OCDF), however, report the measured concentration and indicate that the value exceeds the upper calibration standard.

12.7. The total concentration for each homologous series of PCDD and PCDF is calculated by summing up the concentrations of all positively identified isomers of each homologous series. Therefore, the total should also include the 2,3,7,8-substituted congeners. The total number of GC signals included in the homologous total concentration value may be specified in the report.

12.8. Sample-Specific Estimated Detection Limit

The sample-specific estimated detection limit (EDL) or estimated quantiation limit (EQL, 8290A) is the concentration of a given analyte required to produce a signal with a peak height of at least 2.5 times the background signal level. An EDL/EQL is calculated for each 2,3,7,8-substituted congener that is not identified, regardless of whether or not other non-2,3,7,8-substituted isomers are present. Two methods of calculation can be used, as follows, depending on the type of response produced during the analysis of a particular sample.

12.8.1. Samples giving a response for both quantitation ions (Tables 6 and 9) that is less than 2.5 times the background level.

Use the expression for EDL/EQL (specific 2,3,7,8-substituted PCDD/PCDF) below to calculate an EDL/EQL for each absent 2,3,7,8-substituted PCDD/PCDF (i.e., S/N <2.5). The background level is determined by measuring the range of the noise (peak to peak) for the two quantitation ions (Table 6) of a particular 2,3,7,8-substituted isomer within an homologous series, in the region of the SICP trace corresponding to the elution of the isotope dilution analyte (if the congener possesses an isotope dilution analyte) or in the region of the SICP where the congener is expected to elute by comparison with the routine calibration data (for those congeners that do not have a ^{13}C-labeled standard), multiplying that noise height by 2.5, and relating the product to an estimated concentration that would produce that product height.

NOTE: The quantitation ions for both the unlabeled PCDDs/PCDFs and their isotope dilution analyte must be consistently paired (using either both lighter mass ions or both heavier mass ions).

Use the formula:

$$EDL_{Specific\,2,3,7,8-subst.\,PCDD/PCDF} = \frac{2.5 \times H_x \times Q_{IDA}}{H_{IDA} \times W \times RRF(n)}$$

Where:

EDL = estimated detection limit for homologous 2,3,7,8-substituted PCDDs/PCDFs. (also EQL for Method 8290A)

H_x = height of the average noise for one of the quantitation ions (Table 6) for the unlabeled PCDDs/PCDFs.

H_{IDA} = height of one of the quantitation ions (Table 6) for the labeled isotope dilution analytes.

W, RRF (n), and Q_{IDA} retain the same meanings as defined in Section 12.2

12.8.2. Samples characterized by a response above the background level with a S/N of at least 2.5 for at least one of the quantitation ions (Tables 6 and 9).

When the response of a signal having the same retention times as a 2,3,7,8-substituted congener has a S/N in excess of 2.5 and does not meet any of the other qualitative identification criteria listed in Section 12.1, calculate the "Estimated Maximum Possible Concentration" (EMPC) according to the expression shown in Section 12.1, except that Ax in Section 12.1 should represent the sum of the area under the smaller peak and of the other peak area calculated using the theoretical chlorine isotope ratio. Alternatively, an EDLEQL can be calculated using the above formula and the height of one of the ions as appropriate.

12.9. The relative percent difference (RPD) is calculated as follows:

$$RPD = \frac{|S_1 - S_2|}{(S_1 + S_2)/2} \times 100$$

S_1 and S_2 represent sample and duplicate sample results.

12.10. The 2,3,7,8-TCDD toxic equivalents (TEQ) of PCDDs and PCDFs present in the sample are calculated at the data user's request. This method assigns a 2,3,7,8-TCDD toxicity equivalency factor (TEF) to each of the seventeen 2,3,7,8-substituted PCDDs and PCDFs (Table 10). The 2,3,7,8-TCDD equivalent of the PCDDs and PCDFs present in the sample is calculated by summing the TEF times their concentration for each of the compounds or groups of compounds listed in Table 10.

12.11. Two-GC Column TEF Determination

12.11.1. The concentration of 2,3,7,8-TCDD (see note below), is calculated from the analysis of the sample extract on the 60m DB-5 fused silica capillary column. The chromatographic separation of this isomer must be $\leq$ 25% valley.

12.11.2. For samples that have a positive result for 2,3,7,8-TCDF on the DB-5 column, the extract is reanalyzed on a 30m DB-225 fused silica column. The GC/MS conditions are altered so that only the first descriptor (Table 6) is used. The reported concentration for 2,3,7,8-TCDF is then the result above the lower calibration limit is calculated from the DB-225 analysis. The chromatographic separation between 2,3,7,8-TCDF and any other unlabeled TCDF isomers must be < 25% valley using the column performance check solution for the DB-225 column. Concentration calculations are performed as in Section 12.1 through 12.6.

12.11.3. A DB-225 column can be used in the quantitative analysis of 2,3,7,8-TCDF and 2,3,7,8-TCDD analytes. Since the DB-225 cannot resolve 2,3,7,8-TCDD any positively identified 2,3,7,8-TCDD which exceeds the reporting limit shall be confirmed on a DB-5 column.

12.11.4. For a gas chromatographic peak to be identified as a 2,3,7,8-substituted PCDD/PCDF congener, it must meet the ion abundance (Section 11.5.4) and signal-to-noise ratio criteria. In addition, the retention time identification criterion described in Section 11.5.4 applies here for congeners for which a carbon-labeled analog is available in the sample extract. However, the relative retention time (RRT) of the 2,3,7,8-substituted congeners for which no carbon-labeled analogs are available must fall within 0.006 units of the carbon-labeled standard RRT. Experimentally, this is accomplished by using the attributions described in Table 11 and the results from the routine

calibration run on the DB-5 column.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

It must be documented that all applicable system performance criteria specified were met before analysis of any sample is performed. Table 7 provides recommended GC conditions that can be used to satisfy the required criteria. A GC column performance check is only required at the beginning of each 12-hour period during which samples are analyzed.

13.5. GC Column Performance

13.5.1. Inject 1 or 2 µL of the column performance check solution and acquire selected ion monitoring (SIM) data as described in Section 6.1.3 within a total cycle time of < 1 second.

13.5.2. The chromatographic separation between 2,3,7,8-TCDD and the peaks representing any other TCDD isomers must be resolved with a valley of ≤ 25

percent (Figure 2),

Where:

$$\text{Valley Percent} = (x/y) \times 100$$

x = measured as in Figure 2 from the 2,3,7,8-closest TCDD eluting isomer,

y = the peak height of 2,3,7,8-TCDD

13.5.3. It is the responsibility of the laboratory to verify the conditions suitable for the appropriate resolution of 2,3,7,8-TCDD from all other TCDD isomers. The GC column performance check solution also contains the known first and last PCDD/PCDF eluters under the conditions specified in this protocol. Their retention times are used for qualitative and quantitative purposes. The peak for 2,3,7,8-TCDD must be labeled on the chromatograms. The chromatograms showing the first and last eluters of a homologous series must be included.

13.5.4. The retention times for the switching of SIM ions characteristic of one homologous series to the next higher homologous series must be indicated in the SICP. Accurate switching at the appropriate times is absolutely necessary for accurate monitoring of these compounds.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Autovials containing assorted solvents and extracts. As the autovials are removed from the instrument after analysis, they are collected in archive boxes and retained pending additional instructions. When no longer needed, the archive boxes are moved to the waste disposal area for disposal as PCB waste.

16. REFERENCES/CROSS REFERENCES

16.1. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update III. Method 8290 Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by high-Resolution Mass Spectrometry September 1994.

16.2. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update IV. Method 8290A Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by high-Resolution Mass Spectrometry February 2007.

16.3. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update III. Method 0023A, Sampling Method for Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans Emissions from Stationary Sources. December 1996.

16.4. Compendium Method TO-9A “Determination of Polychlorinated, Polybrominated, and Brominated, Cholorinated Dibenxo-p-dioxins and Dibenzofurans in Ambient Air”, EPA compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, second edition, January 1997.

16.5. Protocol for the Analysis of 2,3,7,8-TCDD by HRGC/HRMS". J. S. Stanley and T. M. Sack, EPA 600/4-86-004.

16.6. “Safety in Academic Chemistry Laboratories", American Chemical Society Publication, Committee on Chemical Safety (3rd Edition, 1979.)

16.7. “Carcinogens - Working with Carcinogens". Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control. National Institute for Occupational Safety and Health. Publication No. 77-206, August 1977.

16.8. "OSHA Safety and Health Standards, General Industry", (29 CFR 1910) Occupational Safety and Health Administration, OSHA 2206 (revised January 1976).

17. METHOD MODIFICATIONS

17.1. Modifications from EPA 8290 and EPA 8290A

17.1.1. The methods specify that 2 µL injections are used throughout the analysis. If an instrument demonstrates adequate sensitivity and chromatographic resolution, then the analyst may use 1 µL injections for all performance checks, standards, QC samples, and samples.

17.1.2. In Section 2.7 of Method 8290 and 8290A, a retention time window of 0.005 RT units is used to tentatively identify unlabeled PCDD/PCDFs for which there are no corresponding labeled isotope dilution analytes. All available labeled isotope dilution analytes are used; therefore, a retention time window

of -1 to +3 seconds is used to identify all compounds. See Section 7.8.4.1 of Method 8290 and 7.9 of Method 8290A.

17.1.3. Tetradecane instead of nonane is used as the final solvent to increase the stability of extracts and standards. Tetradecane is less volatile than nonane. Loss of analyte as a result of solvent incompatibility is monitored through recovery checks and calibration acceptance criteria.

17.2. Modifications from TO-9A method

17.2.1. The ^{37}Cl-2,3,7,8-TCDD surrogate is present at varying levels in the calibration curve (0.5-200 pg/ µL).

17.2.2. The laboratory uses 2 labeled internal standards for the quantitation of labeled isotope dilution analytes.

17.2.3. The final volume is adjusted to 20 µL in tetradecane.

17.2.4. Calibration and quantitation are performed in accordance to this SOP.

18. ATTACHMENTS

18.1. Table 1 - Types of Matrices

18.2. Table 2 - Composition of the Sample Fortification and Internal Standard Solutions.

18.3. Table 3 - The Fifteen 2,3,7,8-Substituted PCDD and PCDF Congeners

18.4. Table 4 - Isomers of Chlorinated Dioxins and Furans

18.5. Table 5 - Concentrations of Calibration Solutions

18.6. Table 6 - Ions Monitored for PCDDs/PCDFs

18.7. Table 7 - Recommended GC Operating Conditions

18.8. Table 8 - Congeners in the GC Performance Evaluation Solution (DB-5)

18.9. Table 9 - Theoretical Ion Abundance Ratios and Control Limits

18.10. Table 10 - 2,3,7,8-TCDD Equivalent Factors

18.11. Table 11 - TEF: Analyte Relative Retention Time Reference Attributes

18.12. Figure 1 - Compound Structure

18.13. Figure 2 - GC Performance Check Chromatogram on the DB-5 Column

18.14. Figure 3 - PFK Peak Profile

18.15. Figure 4 - Manual Determination of Signal-to-Noise

18.16. Appendix A - Periodic Wipe Test Performance

19. REVISION HISTORY

19.1. WS-ID-0005, Revision 7.5, Effective 04/19/2013

19.1.1. Replaced all instances of ‘internal standard’ with isotope dilution analyte’ and all instances of ‘recovery standard’ with ‘internal standard’ to conform with TALS naming guidelines.

19.1.2. Editorial revisions.

19.2. WS-ID-0005, Revision 7.4, Effective 01/14/2011.

19.2.1. Editorial revisions.

19.3. WS-ID-0005, Revision 7.3, Effective 12/30/2009

19.3.1. Editorial revisions.

19.4. WS-ID-0005, Revision 7.2, Effective 11/02/2009

19.4.1. Section 6.1: Inserted “Preventive and routine maintenance is described in the ‘Schedule of Routine Maintenance’ in the QAM.”

19.4.2. Section 12.1.2: Removed the word "presumptive" and inserted "above the lower calibration limit" after the word result.

TABLE 1

Types of Matrices, Sample Sizes and 2,3,7,8-TCDD-Based Method Calibration Limits (Parts per Trillion)

	Water	Soil Sediment Paper Pulp	Fly Ash	Human/ Fish Tissue	Adipose Tissue	Sludges, Fuel Oil	Still-Bottom	Ambient or Source Samples
Lower MCL(a)	0.01	1.0	2.0	1.0	2.0	10	20	40
Upper MCL(a)	4.0	400	400	400	400	2000	4000	8000
Weight (g)	1000	10	10	10	10	2.0	1.0	1 sample
IDA Spiking Levels (ng)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0
Final Extract Volume (µL)	20	20	20	20	20	20	20	20

(a) For other congeners, multiply the values by 1 for TCDF, by 5 for PeCDD/PeCDF/HxCDD/HxCDF/HpCDD/HpCDF, and by 10 for OCDD/OCDF.

TABLE 2

Composition of the Sample Fortification and Internal Standard Solutions

Analyte	Sample Fortification Solution Concentration pg/µL; Solvent: Isooctane	Internal Standard Solution Concentration pg/µL; Solvent: Tetradecane
^{13}C-2,3,7,8-TCDD	2[a], 100[c]	--
^{13}C -2,3,7,8-TCDF	2[a], 100[c]	--
^{13}C -1,2,3,4-TCDD	--	100
^{13}C -1,2,3,7,8-PeCDD	2[a], 100[c]	--
^{13}C -1,2,3,7,8-PeCDF	2[a], 100[c]	--
^{13}C -1,2,3,6,7,8-HxCDD	2[a], 100[c]	--
^{13}C -1,2,3,4,7,8-HxCDF[d]	2[a], 100[c]	--
^{13}C -1,2,3,7,8,9-HxCDD	--	100
^{37}Cl-2,3,7,8-TCDD[b][c]	0.8[b], 100[c]	
	100[c]	
^{13}C -2,3,4,7,8-PeCDF[c]	100[c]	
^{13}C -1,2,3,6,7,8-HxCDF[c][d]	100[c]	
^{13}C -1,2,3,4,7,8-HxCDD[c]	100[c]	
^{13}C -1,2,3,4,7,8,9-HpCDD[c]	100[c]	
^{13}C -1,2,3,4,6,7,8-HpCDD	2[a], 100[c]	--
^{13}C -1,2,3,4,6,7,8-HpCDF	2[a], 100[c]	--
^{13}C -OCDD	4[a], 200[c]	--

(a) Standard 8290, 8290A, Method 23, Method 0023A, TO9 and TO9A Sample Fortification Solution concentrations
(b) Method TO9 and TO9A surrogate concentrations
(c) Method 23 and Method 0023A surrogate concentrations
(d) ^{13}C-1,2,3,6,7,8-HxCDF is used as a Sample Fortification Solution and ^{13}C -1,2,3,4,7,8-HxCDF is used as a surrogate solution in Method 0023A

TABLE 3

The Seventeen 2,3,7,8-Substituted PCDD and PCDF Congeners

PCDD	PCDF
2,3,7,8-TCDD(*)	2,3,7,8-TCDF(*)
1,2,3,7,8-PeCDD(*)	1,2,3,7,8-PeCDD(*)
1,2,3,6,7,8-HxCDD(*)	2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDD	1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDD(+)	1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDD(*)	1,2,3,4,7,8-HxCDF(*)
1,2,3,4,5,6,7,8-OCDD(*)	2,3,4,6,7,8-HxCDF
	1,2,3,4,6,7,8-HpCDF(*)
	1,2,3,4,7,8,9-HpCDF
	1,2,3,4,5,6,7,8-OCDF

(*)The ^{13}C -labeled analog is used as an isotope dilution analyte.
(+)The ^{13}C -labeled analog is used as a internal standard.

TABLE 4

Isomers of Chlorinated Dioxins and Furans as a Function of the Number of Chlorine Atoms

# of Chlorine Atoms	# of Dioxin Isomers	# of 2,3,7,8 Isomers	# of Furan Isomers	# of 2,3,7,8 Isomers
1	2	---	4	---
2	10	---	16	---
3	14	---	28	---
4	22	1	38	1
5	14	1	28	2
6	10	3	16	4
7	2	1	4	2
8	1	1	1	1
Total	**75**	**7**	**135**	**10**

TABLE 5

High Resolution Concentration Calibration Solutions

	Compound	Concentration (ng/mL)				
RRF (n)(m)		**CS2**	**CS3**	**CS4 (ICV(6))**	**CS5**	**CS6**
	Native CDDs and CDFs					
1	2,3,7,8-TCDD	0.5	2	10	40	200
2	2,3,7,8-TCDF	0.5	2	10	40	200
3	1,2,3,7,8-PeCDD	2.5	10	50	200	1000
4	1,2,3,7,8-PeCDF	2.5	10	50	200	1000
5	2,3,4,7,8-PeCDF	2.5	10	50	200	1000
6	1,2,3,4,7,8-HxCDD	2.5	10	50	200	1000
7	1,2,3,6,7,8-HxCDD	2.5	10	50	200	1000
8	1,2,3,7,8,9-HxCDD	2.5	10	50	200	1000
9	1,2,3,4,7,8-HxCDF	2.5	10	50	200	1000
10	1,2,3,6,7,8-HxCDF	2.5	10	50	200	1000
11	1,2,3,7,8,9-HxCDF	2.5	10	50	200	1000
12	2,3,4,6,7,8-HxCDF	2.5	10	50	200	1000
13	1,2,3,4,6,7,8-HpCDD	2.5	10	50	200	1000
14	1,2,3,4,6,7,8-HpCDF	2.5	10	50	200	1000
15	1,2,3,4,7,8,9-HpCDF	2.5	10	50	200	1000
16	OCDD	5.0	20	100	400	2000
17	OCDF	5.0	20	100	400	2000
	Labeled CDDs and CDFs					
18	$^{13}C_{12}$-2,3,7,8-TCDD	100	100	100	100	100
19	$^{13}C_{12}$-2,3,7,8-TCDF	100	100	100	100	100
20	$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100
21	$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	100	100	100	100
	$^{13}C_{12}$-2,3,4,7,8-PeCDF	100	100	100	100	100
	$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100	100	100	100	100
22	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100
23	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100	100	100	100	100
	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100
	$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	100	100	100	100	100
	$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	100	100	100	100	100
24	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100
25	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100
	$^{13}C_{12}$-1,2,3,4,7,8,9-	100	100	100	100	100

	Compound	Concentration (ng/mL)				
RRF (n)(m)		**CS2**	**CS3**	**CS4 (ICV(6))**	**CS5**	**CS6**
	HpCDF					
26	$^{13}C_{12}$-OCDD	200	200	200	200	200
	Cleanup Standard/ FS					
	$^{37}Cl_4$-2,3,7,8-TCDD	0.5	2	10	40	200
	Internal Standards					
	$^{13}C_{12}$-1,2,3,4-TCDD	100	100	100	100	100
	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 6*
Elemental Compositions and Exact Masses of the Ions
Monitored by HR/MS for PCDD's and PCDF's

Descriptor	Exact m/z [1]	m/z Type	Elemental Composition	Substance [2]
1	292.9825	QC	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF [3]
	317.9389	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF [3]
	319.8965	M	$C_{12}H_4{}^{35}Cl_4O_2$	TCDD
	321.8936	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD [4]
	330.9792	Lock	C_7F_{13}	PFK
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD [3]
	333.9339	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD [3]
	339.8597	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF
	341.8567	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}ClO$	PeCDF
	375.8364	M+2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M+2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCDPE
2	330.9792	QC	C_7F_{13}	PFK
	339.8597	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF
	341.8567	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	342.9792	Lock	C_8F_{12}	PFK
	351.9000	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF
	353.8970	M+4	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF [3]
	354.9792	Lock	C_9F_{13}	PFK
	355.8546	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD
	357.8516	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	366.9793	QC	C_9F_{13}	PFK
	367.8949	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD [3]
	369.8919	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD [3]
	409.7974	M+2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCDPE
3	373.8208	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF
	375.8178	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	380.9760	Lock	C_8F_{15}	PFK
	383.8639	M	$^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF [3]
	385.8610	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF [3]
	389.8157	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	Lock	C_9F_{15}	PFK
	401.8559	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD [3]
	403.8529	M+4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD [3]
	430.9728	QC	C_9F_{17}	PFK
	445.7550	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
4	392.9760	QC	C_9F_{15}	PFK
	407.7818	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF

Descriptor	Exact m/z [1]	m/z Type	Elemental Composition	Substance [2]
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF [3]
	419.8220	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF [3]
	423.7766	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	430.9729	Lock	C_9F_{17}	PFK
	435.8169	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD [3]
	437.8140	M+4	$^{13}C_{12}H^{35}Cl_5{}^{37}CL_2O_2$	HpCDD [3]
	479.7165	M+4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCDPE
5	392.9760	QC	C_9F_{15}	PFK
	441.7428	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	442.9728	Lock	$C_{10}F_{17}$	PFK
	443.7399	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M+2	$^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD [3]
	471.7750	M+4	$^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD [3]
	479.7165	M+4	$C_{12}Cl_8{}^{37}Cl_2O$	NCDPE
	513.6775	M+4	$^{13}C_{12}{}^{35}Cl_8{}^{37}Cl_2O$	DCDPE

---

[a] The following nuclidic masses were used:

H =	1.007825	O =	15.994915
C =	12.000000	^{35}Cl =	34.968853
^{13}C =	13.003355	^{37}Cl =	36.965903
F =	18.9984		

S = Isotope dilution analyte/internal standard

*The homologous groups for functions 1-3 do not use the same lockmass as described in Table 6. They use masses 316.9824, 366.9792, and 380.9760, respectively.

TABLE 7

Recommended GC Operating Conditions

The GC Operating Conditions (Temperatures (°C), and Times (minutes)) Are as Follows:

Injector Temperature: 280°C
Interface Temperature: 280°C
Initial Temperature and Time: 190°C / 1 Minute

Temperature Program: 190°C, increasing at a rate of 4°C per minute up to 240°C, and maintaining at this temperature until the last tetra of the tetra- group has eluted from the column. (The total time required for this is approximately 25 minutes, depending on the length of the column). The maintained temperature of 240°C is then increased to 320°C at the rate of 20°C per minute and held at this level until the last compound (octa-group) has eluted from the column.

TABLE 8

PCDD and PCDF Congeners Present in the GC Performance Evaluation Solution and Used for Defining the Homologous GC Retention Time Windows on a 60-M DB-5 Column[(b)]

# of Chlorine Atoms	PCDD Positional Isomer		PCDF Positional Isomer	
	Early Eluter	Late Eluter	Early Eluter	Late Eluter
4[(a)]	1,3,6,8	1,2,8,9	1,3,6,8	1,2,8,9
5	1,2,4,6,8/1,2,4,7,9	1,2,3,8,9	1,3,4,6,8	1,2,3,8,9
6	1,2,3,4,6,8	1,2,3,4,6,7	1,2,3,4,6,8	1,2,3,4,8,9
7	1,2,3,4,6,7,8	1,2,3,4,6,7,9	1,2,3,4,6,7,8	1,2,3,4,6,7,9
8	1,2,3,4,6,7,8,9		1,2,3,4,6,7,8,9	

[(a)] In addition to these two PCDD isomers, the 1,2,3,4-, 1,2,3,7-, 1,2,3,8-, 2,3,7,8-, $^{13}C_{12}$-2,3,7,8-, and 1,2,3,9-TCDD isomers must also be present.

(b) The PCDF Congeners present in GC the Performance Evaluation Solution for the 30 m DB-225 column include:

- 1,2,3,9-TCDF
- 2,3,7,8-TCDF
- 2,3,4,7-TCDF
- $^{13}C_{12}$-2,3,7,8-TCDF

Column performance criteria is met when the percent valleys between the 2,3,7,8-TCDF analyte and the closest eluting isomers are $\leq$ 25%.

TABLE 9

Theoretical Ion Abundance Ratios and Their Control Limits for PCDDs and PCDFs

# of Chlorine Atoms	Ion Type	Theoretical Ratio	Control Limits	
			Lower	Upper
4	M / M+2	0.77	0.65	0.89
5	M+2 / M+4	1.55	1.32	1.78
6	M+2 / M+4	1.24	1.05	1.43
6[(a)]	M / M+2	0.51	0.43	0.59
7[(b)]	M / M+2	0.44	0.37	0.51
7	M+2 / M+4	1.04	0.88	1.20
8	M+2 / M+4	0.89	0.76	1.02

(a) Used only for ^{13}C-HxCDF (IS) (b) Used only for ^{13}C-HpCDF (IS)

TABLE 10

2,3,7,8-TCDD Equivalent Factors (TEFs) for the Polychlorinated Dibenzodioxins and Dibenzofurans

Number	Compound(s)	TEF
1	2,3,7,8-TCDD	1.00
2	1,2,3,7,8-PeCDD	0.50
3	1,2,3,6,7,8-HxCDD	0.10
4	1,2,3,7,8,9-HxCDD	0.10
5	1,2,3,4,7,8-HxCDD	0.10
6	1,2,3,4,6,7,8-HpCDD	0.01
7	OCDD	0.001
8	2,3,6,7-TCDF	0.1
9	1,2,3,7,8-PeCDF	0.05
10	2,3,4,7,8PeCDF	0.5
11	1,2,3,6,7,8-HxCDF	0.1
12	1,2,3,7,8,9-HxCDF	0.1
13	1,2,3,4,7,8-HxCDF	0.1
14	2,3,4,6,7,8-HxCDF	0.1
15	1,2,3,4,6,7,8-HpCDF	0.01
16	1,2,3,4,7,8,9-HpCDF	0.01
17	OCDF	0.001

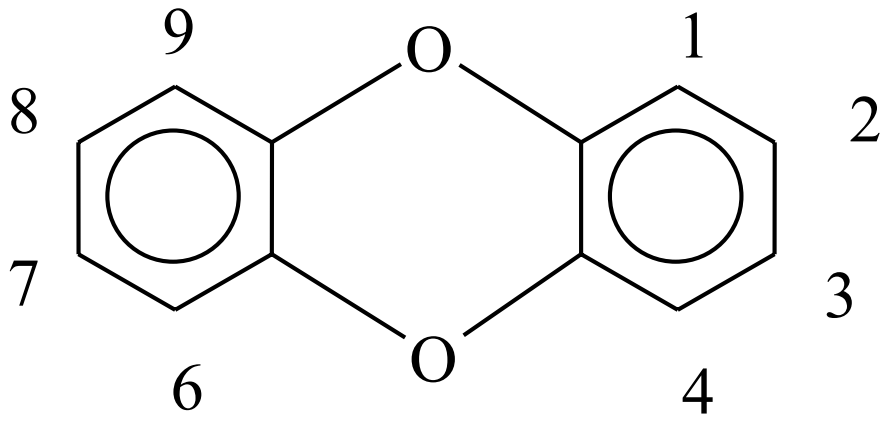
TABLE 11

Toxicity Equivalency Factor:
Analyte Relative Retention Time Reference Attributes

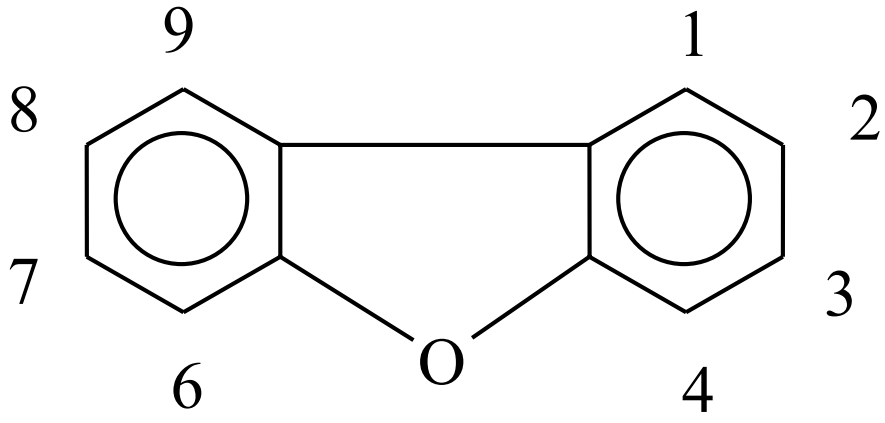
Analyte	Analyte RRT Reference (a)
1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF
1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF
2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF

(a) The retention time of 2,3,4,7,8-PeCDF on the DB-5 column is measured relative to $^{13}C_{12}$-1,3,7,8-PeCDF and the retention time of 1,2,3,4,7,8,9-HpCDF relative to $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF

FIGURE 1
Structure of Dibenzodioxin and Dibenzofuran

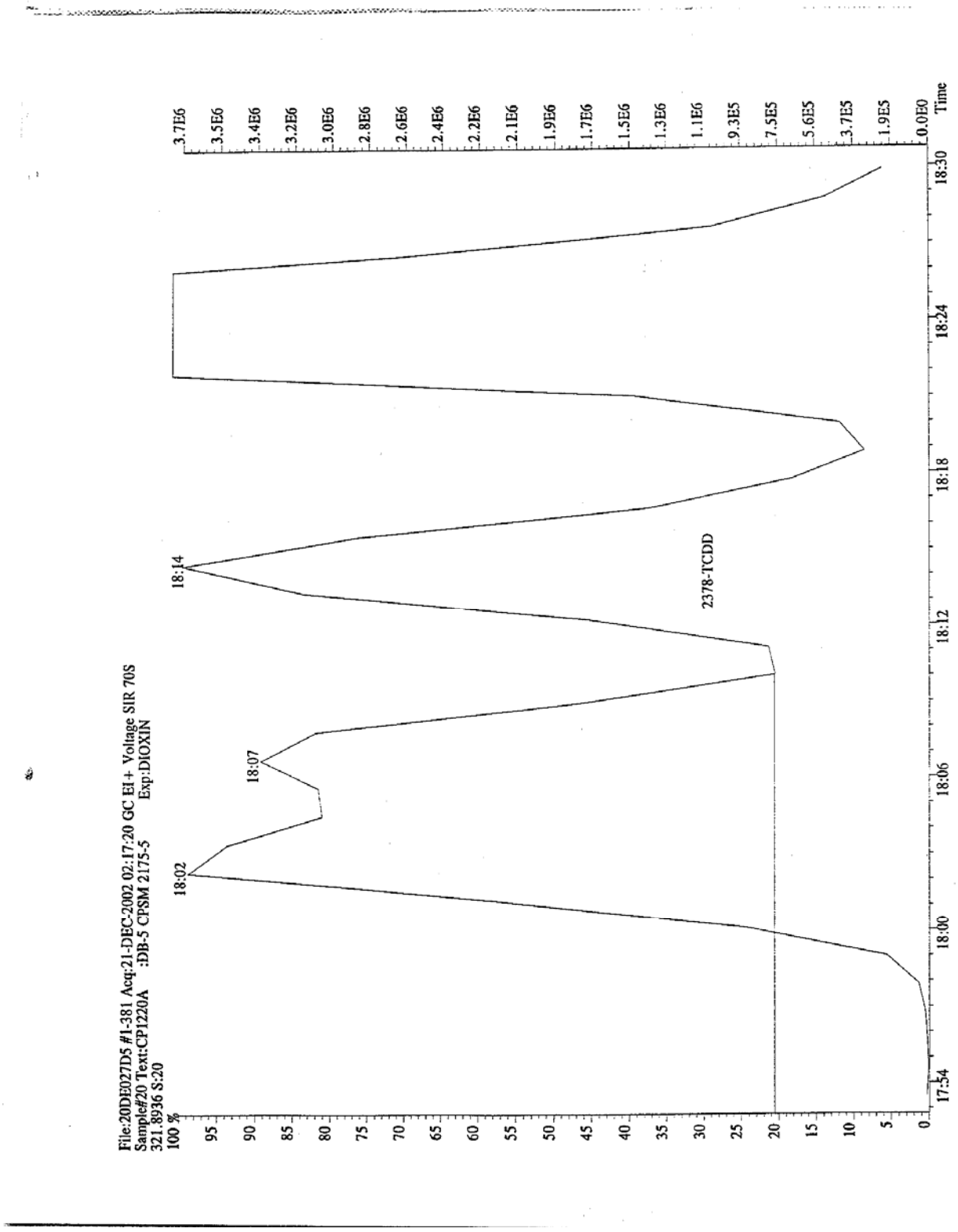


Dibenzodioxin



Dibenzofuran

FIGURE 2


File:20DE027D5 #1-381 Acq:21-DEC-2002 02:17:20 GC EI+ Voltage SIR 70S
Sample#20 Text:CP1220A :DB-5 CPSM 2175-5 Exp:DIOXIN
321.8936 S:20
100 %
18:02
18:07
18:14
2378-TCDD
Time
17:54
18:00
18:06
18:12
18:18
18:24
18:30
3.7E6
3.5E6
3.4E6
3.2E6
3.0E6
2.8E6
2.6E6
2.4E6
2.2E6
2.1E6
1.9E6
1.7E6
1.5E6
1.3E6
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9.3E5
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5.6E5
3.7E5
1.9E5
0.0E0

Figure 3

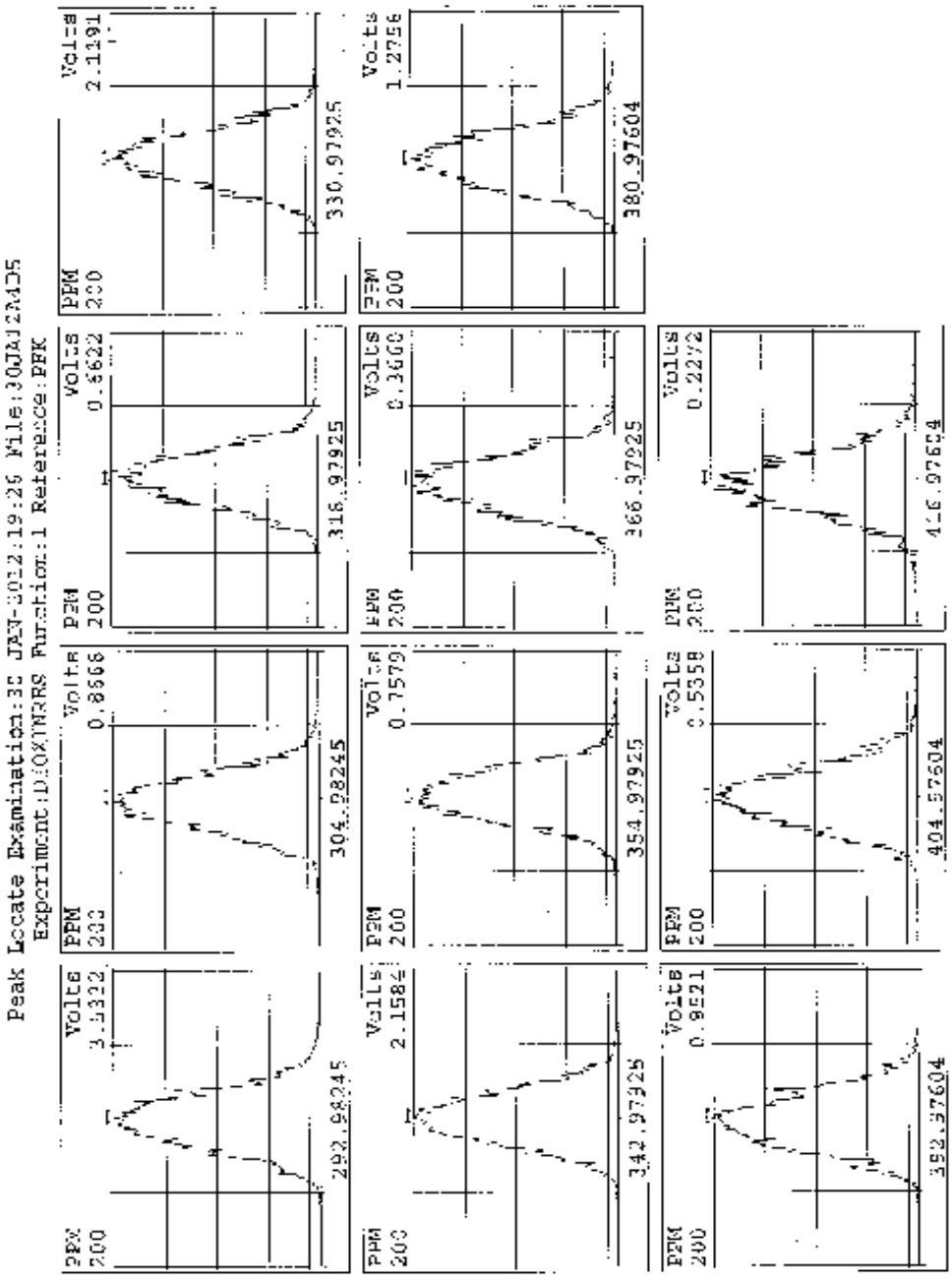
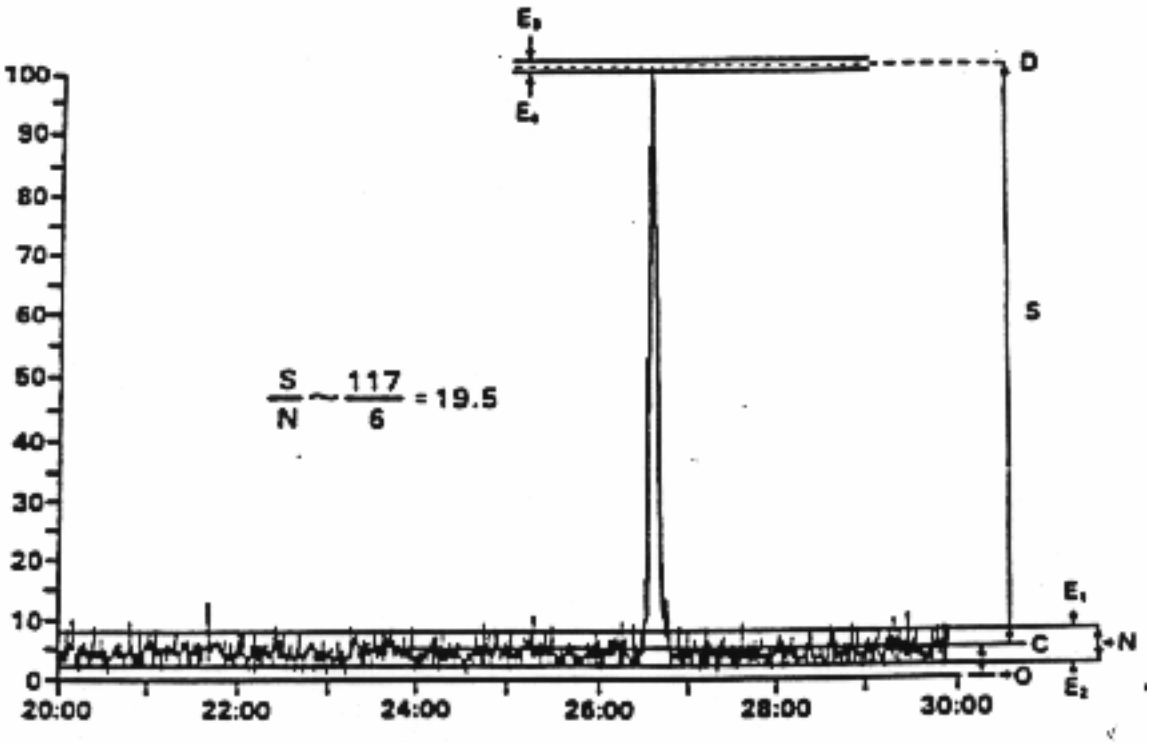

Peak Locate Examination:30 JAN-2012:19:26 File:30JA12A4D5
Experiment:D:OXTNRRS Function:1 Reference:PFK
PPM 200
Volts 3.5332
292.98245
Volts 2.1584
342.97925
Volts 0.9521
352.97604
Volts 0.8666
304.98245
Volts 0.7579
354.97925
Volts 0.5358
404.97604
Volts 0.6622
316.97925
Volts 0.3660
366.97925
Volts 0.2272
416.97604
Volts 2.1191
330.97925
Volts 1.2756
380.97604

FIGURE 4



Manual determination of S/N.

The peak height (S) is measured between the mean noise (lines C and D). These mean signal values are obtained by tracing the line between the baseline average noise extremes, E1 and E2, and between the apex average noise extremes, E3 and E4, at the apex of the signal.

NOTE: It is imperative that the instrument interface amplifier electronic zero offset be set high enough so that negative going baseline noise is recorded.

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Revision 0
November 1992

APPENDIX A

This procedure is designed for the periodic evaluation of potential contamination by 2,3,7,8-substituted PCDD/PCDF congeners of the working areas inside the laboratory.

PERFORMING WIPE TEST

Perform the wipe tests on surface areas of two inches by one foot with laboratory wipers saturated with distilled-in-glass acetone or appropriate solvent using a pair of clean stainless steel forceps. Use one wiper for each of the designated areas. Combine the wipers to one composite sample in an extraction jar containing 200 mL distilled-in-glass hexane. Place an equal number of unused wipers in 200 mL hexane and use this as a control.

SAMPLE PREPARATION

Close the jar containing the wipes and 200 mL hexane and extract for 20 minutes using a wrist-action shaker. Use an appropriate means to reduce the volume to approximately 1.0 mL. Put through an alumina column to clean up potential interfering compounds. Add appropriate amount of internal standard.

EXTRACT ANALYSIS

Concentrate the contents of the vial to a final volume of 20 µL (either in a minivial or in a capillary tube). Inject 2 µL of each extract (wipe and control) onto a capillary column and analyze for 2,3,7,8-substituted PCDDs/PCDFs as specified in the analytical method Section 11 (this exhibit). Perform calculations according to Section 12 (this exhibit).

REPORTING FORMAT

Report the presence of 2,3,7,8-substituted PCDDs and PCDFs as a quantity (pg or ng) per wipe test experiment (WTE). Under the conditions outlined in this analytical protocol, a lower limit of calibration of 25 pg/WTE is expected for 2,3,7,8-TCDD. A positive response for the blank (control) is defined as a signal in the TCDD retention time window at any of the masses monitored which is equivalent to or above 8 pg of 2,3,7,8-TCDD per WTE. For other congeners, use the multiplication factors listed in Table 1, footnote (a) (e.g., for OCDD, the lower MCL is 25 x 5 = 125 pg/WTE and the positive response for the blank would be 8 x 5 = 40 pg). Also, report the recoveries of the isotope dilution analytes during the simplified cleanup procedure.

FREQUENCY OF WIPE TESTS

Wipe tests should be performed when there is evidence of contamination in the method blanks.

CORRECTIVE ACTION

An upper limit of 25 pg per TCDD isomer and per wipe test experiment is allowed. (Use multiplication factors listed in footnote (a) from Table 1 for other congeners.) This value corresponds to the lower calibration limit of the analytical method. Steps to correct the contamination must be taken whenever these levels are exceeded. To that effect, first vacuum the working places (hoods, benches, sink) using a vacuum cleaner equipped with a high-efficiency particulate absorbent (HEPA) filter and then wash with a detergent. A new set of wipes should be analyzed before anyone is allowed to work in the dioxin area of the laboratory.

The test results and the decontamination procedure must be reviewed with EH&S.

`Title: Preparation of Samples for Analysis of Polychlorinated Dioxins and Furans for Analysis HRGC/HRMS

[Methods 8290, 8290A & TO-9A]

Approvals (Signature/Date):

Elizabeth Nguyen Technical Manager — Date 12/21/12	Joe Schairer Health & Safety Manager / Coordinator — Date 12/20/12
Douglas Weir Quality Assurance Manager — Date 12/20/12	Karla Buechler Laboratory Director — Date 12/21/12

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1. SCOPE AND APPLICATION

1.1. This method provides procedures for the preparation of samples prior to the analysis of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), polychlorinated dibenzo-p-dioxins (tetra- through octachlorinated homologs; PCDDs), and polychlorinated dibenzofurans (tetra- through octachlorinated homologs; PCDFs) in a variety of environmental matrices at part-per-trillion (ppt) concentrations by SW 846 Method 8290. The analytical method calls for the use of high-resolution gas chromatography and high-resolution mass spectrometry (HRGC/HRMS) on purified sample extracts. Refer to Table 1 for the list of analytes. Analysis is by SOP WS-ID-0005.

1.2. The sensitivity of this method is dependent upon the level of interferences within a given matrix.

1.3. This method is designed for use by analysts who are experienced with residue analysis.

1.4. Samples containing concentrations of specific congeners (PCDDs and PCDFs) that are greater than the calibration limit should be analyzed by a protocol designed for such concentrations, such as 8280A/B.

2. SUMMARY OF METHOD

2.1. This procedure uses matrix-specific extraction and analyte-specific cleanup techniques.

2.2. A specified amount (see Table 1) of soil, sediment, fly ash, water, sludge (including paper pulp), still-bottom, fuel oil, chemical reactor residue, air sample (QFF, PUF or XAD media) or fish tissue, is spiked with a solution containing specified amounts of each of nine isotopically (^{13}C) labeled PCDDs/PCDFs listed in Table 2. The sample is then extracted according to a matrix-specified extraction procedure. The extraction procedures are: a) toluene Soxhlet (or equivalent) extraction, for soil, sediment, fly ash samples, aqueous sludges, and solid air matrices (XAD, QFF, PUF); b) methylene chloride liquid-liquid extraction or solid phase extraction for water samples; c) dilution of a small sample aliquot in solvent for wastes/chemical products; and d) toluene (or hexane/methylene chloride) Soxhlet (or equivalent) extraction for fish tissue. This method can also use solid phase extraction (SPE), however, Test America West Sacramento is in the developmental stages for this extraction type and is not currently certified for its use.

2.3. If interferences are present, extracts may be cleaned as described below. The extracts are submitted to an acid and/or base washing treatment and dried. Following a solvent exchange step, the residue is cleaned up by column chromatography on acid/base silica, acid alumina and carbon on silica. The preparation of the final extract for HRGC/HRMS analysis is accomplished by adding 20 µL of a tetradecane solution containing 100 pg/µL of each of the two recovery standards $^{13}C_{12}$-1,2,3,4-TCDD and

$^{13}C_{12}$ -1,2,3,7,8,9-HxCDD (Table 2) to the concentrated eluate. The former is used to determine the percent recoveries of tetra- and penta-chlorinated PCDD/PCDF internal standards while the latter is used for the determination of hexa-, hepta- and octa-chlorinated PCDD/PCDF internal standard percent recoveries. Upon client approval, less final volume can be used to decrease detection limit and more final volume can be used to decrease severe interferences.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

3.3. Internal Standard: An internal standard is a ^{13}C-labeled analog of a congener chosen from the compounds listed in Table 2. Internal standards are added to all samples including method blanks and quality control samples before extraction, and they are used to quantitate the concentration of the analytes. Nine internal standards are used in this method. There is one for each of the dioxin and furan homologs (except for OCDF) with the degree of chlorination ranging from four to eight. Additional internal standards may be added to act as retention time references, but they are not used for quantitation.

3.4. Recovery Standard: Two recovery standards are used to determine the percent recoveries for the internal standards. The $^{13}C_{12}$-1,2,3,4-TCDD is used to measure the percent recoveries of the tetra- and pentachlorinated internal standards while $^{13}C_{12}$-1,2,3,7,8,9-HxCDD is used to determine the recovery of the hexa-hepta- and octachlorinated internal standards. $^{13}C_{12}$-1,2,3,7,8,9-HxCDD also acts as a retention time reference for the unlabeled analog present in sample extracts. They are added to the final sample extract before HRGC/HRMS instrument analysis.

3.5. Cleanup Recovery Standard (CRS): A $^{37}Cl_4$-2,3,7,8-TCDD analog that is added to each sample following extraction to measure the efficiency of the cleanup process.

4. INTERFERENCES

4.1. Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts or elevated baselines that may cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interferents under the conditions of analysis by running laboratory method blanks. Analysts shall not use PVC gloves.

4.2. The use of high-purity reagents and solvents helps minimize interference problems. Purification of solvents by distillation in all-glass systems may be necessary.

4.3. Proper cleaning of glassware is extremely important because glassware may not only contaminate the samples, but may also remove the analytes of interest by adsorption on the glassware surface.

4.3.1. Glassware should be rinsed with solvent and washed with a detergent solution as soon after use as is practical. Sonication of glassware containing a detergent solution for approximately 30 seconds may aid in cleaning. Glassware with removable parts, particularly separatory funnels with Teflon stopcocks, must be disassembled prior to detergent washing.

4.3.2. After detergent washing, glassware should be immediately rinsed with acetone, toluene, hexane, and then methylene chloride.

4.3.3. Do not kiln reusable glassware in an oven as a routine part of cleaning. Kilning may be warranted after particularly dirty samples are encountered, but should be minimized, as repeated kilning of glassware may cause the formation of active sites on the glass surface that will irreversibly adsorb PCDDs/ PCDFs.

4.3.4. Immediately prior to use, Soxhlet (or equivalent) extraction glassware should be pre-extracted with toluene for a minimum of 3 hours. Note: Accelerated extractors such as the Soxtherm can use a shorter cleaning cycle which exhibits subsequent extractions free of cross contamination and interferences.

Note: Re-use of glassware should be minimized to avoid the risk of contamination. All glassware that is re-used must be scrupulously cleaned as soon as possible after use, applying the following procedure:

4.4. Interferences co-extracted from samples will vary considerably from source to source, depending on the diversity of the site being sampled. Interfering compounds may be present at concentrations several orders of magnitude higher than the PCDDs and PCDFs. The most frequently encountered interferences are chlorinated-biphenyls, methoxy biphenyls, hydroxy biphenyl ethers, benzyl phenyl ethers, polynuclear aromatics, and pesticides. Because very low levels of PCDDs and PCDFs are measured by this method, the elimination of interferences is essential. The cleanup steps given in Sections 11.12 thru 11.16 can be used to reduce or eliminate these interferences.

4.4.1. If South Carolina samples show diphenyl ethers at levels that could contribute to positive furan hits, a subsequent clean-up to remove them must be performed.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toes, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Hearing protection must be worn when using mechanical systems to grind fish, tissue, or paper/pulp samples.

5.1.2. Finely divided dry soils contaminated with PCDDs and PCDFs are particularly hazardous because of the potential for inhalation and ingestion. Such samples are to be processed in a confined environment, such as a hood or a glove box.

5.1.3. Assembly and disassembly of glassware creates a risk of breakage and cuts. All staff members shall wear Kevlar or MAPA blue latex cut-resistant gloves over chemically resistant gloves when assembling and disassembling glassware.

5.1.4. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex and vinyl gloves provide no protection against most of the organic solvents used in this method. Nitrile or similar gloves must be used. Latex gloves may be used for methanol.

5.1.5. Exposure to chemicals must be maintained as low as reasonably achievable, therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.6. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.7. The use of separatory funnels to extract aqueous samples with methylene chloride creates excessive pressure very rapidly. The use of separatory funnels during the partition and back extraction of sample extracts can also create excessive pressure. Initial venting should be done immediately after the sample container has been sealed and inverted. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity, and a face shield must be worn over safety glasses or goggles when it is performed. Alternately, the extraction can be performed behind a closed fume hood sash on a mechanical shaker.

5.1.8. When Dean-Stark/Soxhlet clean-ups or extractions are performed overnight or unattended, special precautions must be taken. Open the chiller valves to the system about 15 minutes before the heating elements are turned on, and check every condenser to ensure that it is cold and functioning properly before turning the heating elements on. Check every condenser again about 15 minutes after turning the heating elements on to ensure that they are still cold and functioning properly. If the system is left operating overnight or unattended for an extended period, the first chemist to come back into the lab must again check every condenser to ensure that it is still cold and functioning properly.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Benzene	Flammable Toxic Carcinogen	PEL: 1 ppm TWA ; 5 ppm 15 MIN. STEL	Causes skin irritation. Toxic if absorbed through skin. Causes severe eye irritation. Toxic if inhaled. Vapor or mist causes irritation to mucous membranes and upper respiratory tract. Exposure can cause narcotic effect. Inhalation at high concentrations may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation and/or giddiness, depression, drowsiness or fatigue. Victim may experience tightness in the chest, breathlessness, and loss of consciousness.
Cyclohexane	Flammable Irritant	300 ppm TWA	Inhalation of vapors causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. High concentrations have a narcotic effect.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Isooctane	Flammable Irritant	None established	Inhalation of vapors may cause nausea, headache, dizziness, loss of consciousness, irritation to upper respiratory tract, pain in throat and nose, coughing, wheezing, shortness of breath.
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sodium Hydroxide	Corrosive Poison	2 ppm, 5 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of Sodium Hydroxide dust will cause irritation of the nasal and respiratory system.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydra-dator	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
Tetradecane	Irritant	None established	Inhalation of vapors may cause difficulty breathing, headache, intoxication and central nervous system damage.
Toluene	Flammable Poison Irritant	200 ppm-TWA 300 ppm-Ceiling	Inhalation may cause irritation of the upper respiratory tract. Symptoms of overexposure may include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e. g. pins and needles) or numbness may be produced. Causes severe eye and skin irritation with redness and pain. May be absorbed through the skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

The following list of items does not necessarily constitute an exhaustive compendium of the equipment needed for this analytical method.

6.1. Nitrogen evaporation apparatus with variable flow rate.

6.2. Balances capable of accurately weighing to 0.01 g and 0.0001 g.

6.3. Centrifuge.

6.4. Water bath, equipped with concentric ring covers and capable of maintaining temperature control within ± 2ºC.

6.5. Stainless steel or glass containers large enough to hold contents of one-pint sample containers.

6.6. Drying oven.

6.7. Stainless steel spoons and spatulas.

6.8. Pipettes, disposable, Pasteur, 150 mm long x 5 mm ID.

6.9. Pipettes, disposable, serological, 10 mL, for the preparation of the carbon column specified in Section 7.1.

6.10. Reacti-vial, 2 mL, silanized clear glass.

6.11. Stainless steel meat grinder with a 3- to 5-mm hole size inner plate.

6.12. Separatory funnels, 250 mL.

6.13. Separatory funnels, 1000 mL.

6.14. Teflon® boiling chips (or equivalent) washed with methylene chloride before use.

6.15. Chromatographic column, glass, 300 mm x 10.5 mm, fitted with Teflon® stopcock.

6.16. Adapters for concentrator tubes.

6.17. Glass fiber filters, Whatman GF-D, GF-F, GMF150, or equivalent.

6.18. Solid phase extraction discs, 3M 90mm C18, or equivalent.

6.19. Dean-Stark trap, 5 or 10 mL, with T-joints, condenser and 125 mL flask.

6.20. Continuous liquid-liquid extractor.

6.21. All-glass Soxhlet apparatus, 500 mL flask.

6.22. Soxtherm extraction apparatus (or equivalent), including glass thimble holders, glass beakers, and gaskets.

6.23. Glass funnels, sized to hold 170 mL of liquid.

6.24. Desiccator.

6.25. Turbo evaporator

6.26. Rotary evaporator with a temperature controlled water bath.

6.27. High speed tissue homogenizer, equipped with an EN-8 probe or equivalent.

6.28. Glass wool, extracted with methylene chloride, dried and stored in a clean glass jar.

6.29. Vacuum extraction device for solid phase extraction, 1 Liter glass funnel with 90mm filter disc holder with a vacuum source, Kontes or equivalent.

7. REAGENTS AND STANDARDS

7.1. Column Chromatography Reagents

7.1.1. Silica Gel - Kieselgel 60 or equivalent, activate for 1 hour at 184°C before use. Store at 130°C in covered flask.

7.1.2. Acid Alumina - ICN or equivalent, activated as necessary.

7.1.3. Basic Alumina - ICN or equivalent. No activation required.

7.1.4. Granular carbon/silica gel - Mix 3.6 g granular carbon and 16.4 g activated silica gel; (alternatively, prepare carbon/silica gel (5%/95%); i.e., combine 5 g precleaned carbon with 95 g silica gel). Store at room temperature in a Teflon ® lined covered jar. The first LCS prepared with a new batch of column packing material is the quality control check of the packing materials. Refer to historical control limits before accepting the new batch of material.

7.1.5. 44% H_2SO_4 /silica gel - Mix 24 mL conc. H_2SO_4 and 56 g activated silica gel. Stir and shake until free flowing. Store at room temperature.

7.1.6. 33% NaOH/silica gel - Mix 34 mL 1N NaOH and 67 g activated silica gel. Stir and shake until free flowing. Store at room temperature.

7.2. Acid Alumina Activity Assessment

Alumina activity may vary with the matrix or environmental conditions. Monitor internal standard and cleanup recovery standard recoveries in extract analysis. Low recoveries of cleanup recovery standard (CRS) may indicate loss of alumina activity. Assess stability of alumina activity and apply corrective action as appropriate (reactivate and reprofile).

Note: a column profile should be done to show elution of all 2,3,7,8 substituted analogs so problems can be readily identified.

7.2.1. Profile each vendor lot of activated alumina as corrective action for low internal standard and CRS recoveries dictate. If necessary, proceed as follows:

7.2.1.1. Set up and label 3 acid alumina columns.

7.2.1.2. Pre-rinse with 20 mL hexane.

7.2.1.3. Add 2 mL hexane spiked with internal standards and natives (spike amounts equivalent to those for LCS) with 2X2 mL hexane rinse of fractions.

7.2.1.4. Elute each column with 20 mL hexane. Collect and label these fractions.

7.2.1.5. Elute each column with 5 x10 mL methylene chloride/hexane at the appropriate v/v percent. Collect and label these fractions separately.

7.2.1.6. Elute each column with 10 mL of 100% methylene chloride. Collect and label these fractions. Reduce all fractions to final volume and add recovery standard.

7.2.2. Review data and select an elution scheme. Group the fraction from each solvent system as follows:

7.2.2.1. Pre-analyte fraction - consists of all eluent prior to elution of first target analytes.

7.2.2.2. Analyte fraction - consists of all that contain detectable levels of target analytes.

7.2.2.3. Post-analyte fraction - consists of all eluents after elution of the last target analyte.

7.2.3. Select the solvent system which best meets the following two conditions:

7.2.3.1. Pre-analyte fraction consists of 20mL hexane and no more than 20 mL mixed solvent.

7.2.3.2. Analyte fraction consists of no more than 20mL of mixed solvent and contains greater than 90% of all target analytes and greater than 80% of all internal standards.

7.2.4. After selection of the appropriate solvent system and fractionation pattern, perform triplicate acid alumina cleanups on spiked hexane to ensure reproducibility of the fractionation pattern. Document each elution scheme.

7.2.5. Each subsequent batch of acid alumina used in the lab (from the same vendor lot) must be checked for stable activity.

7.3. Reagents

7.3.1. Sulfuric acid, concentrated, ACS grade, specific gravity 1.84.

7.3.2. Distilled water demonstrated to be free of interferents

7.3.3. 1 N HCl.

7.3.4. Silica gel.

7.3.5. Solution for breaking emulsions: Slowly add 1.0L of reagent grade NaOH solution to a 2.0L NaOH container, containing 1.0L of DI H2O, and leave the container in secondary containment with the lid off.

Warning: The solution will begin to heat so let the solution stand until equilibrium is met and the solution is at room temperature.

When this process is complete, the solution will then be ready for use in the samples.

7.3.6. Precleaned Sodium Sulfate.

7.3.7. Canola Oil (for tissue extraction only), or other suitable oil.

7.4. Desiccating Agent

7.4.1. Sodium sulfate, granular, anhydrous.

7.5. Solvents

7.5.1. High-purity, distilled-in-glass or highest available purity: Methylene chloride, hexane, methanol, tetradecane, isooctane, toluene, cyclohexane, and acetone.

7.6. All daily internal standard, daily clean up recovery standards, and daily spiking solutions are stable for one year from preparation. After 1 year, solutions may be re-verified. The re-verified solution may be used for an additional year, or until there is evidence of compound degradation or concentration. The re-verification must be performed using an unexpired, not previously re-verified solution from a second lot or second vendor.

7.6.1. Sealed ampules may be used until the manufacturer's expiration date is exceeded. If no expiration date is provided, then the expiration date will be 10 years from the date the ampule is opened. The solvent level should be monitored prior to each use to assure there has been no concentration of the standard over time.

7.6.2. Standards for method 8290A require storage at ≤ 6ºC.

7.7. Field Surrogate Solution (air matrices)

This solution contains one ^{37}Cl labeled analog (for Method TO-9/TO-9A) or one ^{37}Cl and four ^{13}C labeled analogs (for Method 0023) at the nominal concentration indicated in Table 2. It is used to assess sample collection and recovery procedures.

7.8. Internal Standard

This isooctane solution contains the nine internal standards at the nominal concentrations that are listed in Table 2. The solution contains at least one carbon-labeled standard for each homologous series, and it is used to measure the concentrations of the native substances. (Note that $^{13}C_{12}$ -OCDF is not present in the solution.)

7.9. Native Spike Standard

Also known as the Matrix Spike or Native Spike solution. Contains all the 2,3,7,8-substituted unlabeled analytes listed in Table 2. Prepare using the appropriate standards to yield a spiking solution with a concentration of 4.0 ng/ml for the tetra-CDDs/CDFs, 20 ng/ml for the penta-, hexa-, and hepta- CDDs/CDFs, and 40 ng/ml for the octa- CDD/CDF.

7.10. Recovery Standard Solution

This tetradecane solution contains two recovery standards ($^{13}C_{12}$-1,2,3,4-TCDD and $^{13}C_{12}$ -1,2,3,7,8,HxCDD). An appropriate volume of this solution is spiked into each sample extract before the final concentration step.

7.11. Cleanup Recovery Standard Solution (CRS)

Prepare $^{37}Cl_4$-2,3,7,8-TCDD at the concentration shown in Table 2, in isooctane (or toluene).

7.12. Preparation and QC of PUF material

7.12.1. The PUF material is purchased pre-cut.

7.12.2. The PUFs are rinsed by Soxhlet with acetone (or other appropriate solvent) for a minimum of 16 hours and air dried for a minimum of 2 hours in a contaminant-free area.

7.12.3. One PUF from the rinsed batch is randomly selected to be the QC sample for the batch.

7.12.4. The PUF is loaded into a pre-cleaned Soxhlet extractor charged with toluene.

7.12.5. The 1613/8290 daily internal standard solution is spiked into the PUF and it

is extracted for a minimum of 16 hours.

7.12.6. The Soxhlet extract is recovered and processed according to Section 11.4.

7.12.7. The batch of PUF is considered acceptable if no target analytes are detected at or above the laboratory or project specific reporting limit.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. The sample collection, shipping, handling, and chain-of-custody procedures are not described in this document. Sample collection personnel will, to the extent possible, homogenize samples in the field before filling the sample containers. This should minimize or eliminate the necessity for sample homogenization in the laboratory. The analyst should make a judgment, based on the appearance of the sample, regarding the necessity for additional mixing. If the sample is clearly non-homogeneous, the entire contents should be transferred to a glass or stainless steel pan for mixing with a stainless steel spoon or spatula before removal of a sample portion for analysis.

8.2. Grab and composite samples must be collected in glass containers.

8.3. Ambient air samples are collected on a Quartz Fiber Filter followed by a glass sleeve containing a polyurethane foam plug.

8.4. Samples from stationary sources are collected on glass or quartz fiber filters and XAD-2 Resin. (See WS-ID-0009 for sample preparation procedures).

8.5. Conventional sampling practices must be followed. Do not rinse the bottle with sample before collection. Sampling equipment must be free of potential sources of contamination.

8.6. Grinding or blending of fish samples.

If not otherwise specified by the client, the whole fish (frozen) should be blended or ground to provide a homogeneous sample. The use of a stainless steel meat grinder with a 3 to 5 mm hole size inner plate is recommended. In some circumstances, analysis of fillet or specific organs of fish may be requested by the client. If so requested by the client, the above whole fish requirement is superseded. More detail can be found in "Tissue Sampling and Handling for a variety of Methods" (WS-WI-0018).

Warning: Hearing protection must be worn when grinding samples.

8.7. With the exception of the fish tissues, which must be stored at - 20°C, all samples should be stored at 4°C ± 2, extracted within 30 days and completely analyzed within 45 days of collection. The 30 day hold time is recommended. PCDDs and PCDFs have demonstrated stability for greater than one year.

8.8. All extracts must be stored capped, in the dark, at room temperature (approximately 21°C to 28°C). All extracts for method 8290A must be stored capped at ≤ 6ºC.

8.9. For moisture determinations refer to SOP WS-OP-0013.

9. QUALITY CONTROL

9.1. One method blank (MB) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The method blank is an aliquot of laboratory matrix (reagent water, sodium sulfate, PUF, XAD, filter, etc.) processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when target analytes are detected in the method blank above the reporting limit or when surrogate recoveries are outside control limits. Re-extraction of the blank, other batch QC, and the affected samples are required when the method blank is deemed unacceptable. The method blank contains a PUF plug, XAD, or filter prepared from the same batch as the field samples whenever possible for air samples.

Certain programs, such as DOD, may require a more stringent evaluation of the method blank, for instance, that the blank not contain any analytes of interest at a concentration greater than ½ the lower calibration limit.

Note: Re-extraction of the blank, QC and affected samples for the air matrices (PUF, XAD, and filter) is not generally possible because the entire sample is consumed in the initial extraction.

9.1.1. If the accompanying samples are aqueous, use distilled water as a matrix. Take the method blank through all steps detailed in the analytical procedure.

9.1.2. Use sodium sulfate as the method laboratory matrix when solids are extracted. Use a mixture of sodium sulfate and canola oil as the matrix when tissues are extracted. Take the method blank through all steps detailed in the analytical procedure.

9.1.3. The method blank must be spiked prior to extraction with the same amount of ^{13}C -labeled internal standards as added to samples.

9.1.4. If method blank contamination is present, check solvents, reagents, fortification solutions, apparatus and glassware to locate and eliminate the source of contamination before any further samples are extracted and analyzed. The presence of any analyte in the method blank ate concentrations greater than the reporting limit (RL) is cause for corrective action.

9.1.4.1. OCDD is a ubiquitous laboratory contaminant. A method blank and the associated samples are deemed acceptable if the OCDD

concentration is <5x the specified reporting limit. Flag data appropriately. The analyst is expected to investigate and eliminate potential sources of systematic contamination.

9.1.4.2. If a target analyte is detected in the blank but the associated samples are ND (not detected), then the data may be reported, unless otherwise directed by the client. Note the action in the narrative.

9.1.4.3. If a target analyte is detected in the blank, but the concentration of the contaminant in the samples >10x the blank concentration, then the data may be reported, unless otherwise directed by the client. Note the action in the narrative.

9.1.4.4. If one of the conditions above is not met then the sample associated with a contaminated method blank must be re-extracted.

9.1.5. If new batches of reagents or solvents contain interfering contaminants, purify or discard them.

9.2. A Laboratory Control Sample (LCS) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water, sodium sulfate, PUF, XAD, etc.) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte is outside control limits provided on the LIMS or by the client. Re-extraction of the blank, other batch QC and all associated samples are required if the LCS is deemed unacceptable. See policy WS-PQA-003 for specific acceptance criteria. When associated with PUF samples, the LCS should contain a PUF plug prepared from the same batch as the field samples whenever possible.

Note: Re-extraction of the blank, QC and affected samples for the air matrices (PUF, XAD, and filter) is not generally possible because the entire sample is consumed in the initial extraction.

9.2.1. A LCS is deemed acceptable if control analytes are above control limits and the associated samples are ND, unless otherwise specified by the client. Note any actions in the narrative.

9.3. The assessment of matrix effects on method performance, as required by NELAP, is met in Method 8290 and 8290A, as in all isotope dilution techniques, with the use of isotopically labeled compounds. These isotopically labeled compounds are analogs of target analytes and are spiked into each sample. Therefore, matrix effects on method performance may be judged by the recovery of these analogs. Sample analysis

acceptance is controlled by the performance of these analogs in each sample. A Matrix Spike/Matrix Spike Duplicate (MS/MSD or MS/SD) pair are extracted at the client's request only. Method 8290A does not address analysis of MS/MSD. An exception to this rule is a batch containing South Carolina samples for Method 8290. These batches must have an MS/MSD prepared. However, South Carolina requires Method 8290A after December 31, 2008. An MS/MSD pair are aliquots of a selected field sample spiked with analytes of known identity and concentration. When requested by the client, the MS/MSD pair shall be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spike analyte is outside control limits provided on the LIMS or by the client. Re-extraction of the blank, the LCS, the selected field sample, and the MS/MSD may be required after evaluation and review. Matrix Spike/ Matrix Spike Duplicates are not generally applicable for air samples due to the difficulty in collecting identical or representative samples. An LCS/LCSD may be extracted to show precision of the extraction and analysis process.

9.3.1. Matrix Spike (MS): A sample, which is spiked with a known amount of the matrix spike fortification solution prior to the extraction step. The recoveries of the matrix spike compounds are determined; they are used to estimate the effect of the sample matrix upon the analytical methodology.

9.3.2. Matrix Spike Duplicate (MSD): A second portion of the same sample as used in the matrix spike analysis and which is treated like the matrix spike sample.

9.3.3. Locate the sample for the MS and MSD analyses (the sample may be labeled "double volume").

9.3.4. Add an appropriate volume of the matrix spike fortification solution, adjusting the fortification level as specified in Table 1, under IS Spiking Levels.

9.3.5. The results obtained from the MS and MSD samples (percent recovery and concentrations of 2,3,7,8-substituted PCDDs/PCDFs) should agree within 20 percent relative difference. Report all results and flag outliers.

9.3.6. Internal standard recoveries are flagged if they are outside the recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any internal standard is less than 10:1.

9.4. Duplicates

9.4.1. Upon client request, duplicates may be processed. Locate the sample specified for duplicate analysis, and prepare and analyze a second 10-g soil or sediment sample portion or 1 L water sample, or an appropriate amount of

the type of matrix under consideration. Duplicate samples are not generally applicable for air samples due to the difficulty in collecting identical or representative samples. A duplicate injection of a sample extract may be performed to display instrument precision.

9.4.1.1. The results of the laboratory duplicates (percent recovery and concentrations of 2,3,7,8-substituted PCDD/PCDF compounds) should agree within 25 percent relative difference. Report all results and flag outliers.

9.4.2. Internal standard recoveries are flagged if they are outside the recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any internal standard is less than 10:1.

9.5. Field Blanks

9.5.1. Each batch of samples may contain a field blank sample of nominally uncontaminated soil, sediment or water that is to be processed for analysis.

9.5.1.1. Weigh a 10-g portion or use 1 L (for aqueous samples) of the specified field blank sample and add the appropriate amount of internal standard to yield 100 pg/µL in the final extract.

9.5.1.2. Extract by using the procedures described in Section 11. As applicable, add the appropriate amount of recovery standard to yield 100 pg/µL in the final extract. Analyze a 1-2 µL aliquot of the concentrated extract using SOP WS-ID-0005.

9.6. Rinsate Samples

9.6.1. In addition to the field blank, a batch of samples may include a rinsate, which is a portion of the solvent (usually trichloroethylene) that was used to rinse sampling equipment. The rinsate is analyzed to assure that the samples were not contaminated by the sampling equipment.

9.6.2. The rinsate sample must be processed like a regular sample.

Take a 100-mL (± 0.5 mL) portion of the sampling equipment rinse solvent (rinsate sample), filter, if necessary, and add the appropriate amount of internal standard to yield 100 pg/µL in the final extract.

9.6.3. Using appropriate methods, concentrate to approximately 10 mL.

9.6.4. Just before analysis, add the appropriate amount of recovery standard to yield 100 pg/µL in the final extract. Reduce the volume to a final volume of 20 µL, as necessary. No column chromatography is required.

9.6.5. Analyze an aliquot following the same procedures used to analyze samples.

9.7. Surrogate/Clean Up Recovery Standard

A surrogate compound may be spiked into all air media samples prior to collection. For all other matrices, a clean up recovery standard is spiked following extraction and just prior to cleanup, in order to monitor relative loss of internal standard during both extraction and cleanup.

9.8. Internal Standards

An internal standard is a ^{13}C -labeled analog of a PCDD/PCDF congener. Internal standards are added to all samples including method blanks and quality control samples before extraction, and they are used to quantitate the concentration of the analytes. Nine internal standards are used in this method. There is one for each of the dioxin and furan homologs (except for OCDF) with the degree of chlorination ranging from four to eight. Additional internal standards may be added to act as retention time references, but they are not used for quantitation.

9.8.1. A 2000 pg aliquot of the internal standard mixture is added to all samples, regardless of sample size. As an example, for $^{13}C_{12}$ -2,3,7,8-TCDD, a 10-g soil sample requires the addition of 2000 pg of $^{13}C_{12}$ -2,3,7,8-TCDD to give the requisite fortification level.

9.8.2. Internal standards must be spiked into all samples, QC samples, and included in all calibrations.

9.8.3. For each sample and QC aliquot, calculate the percent recovery. The percent recovery should be between 40 percent and 135 percent for all nine internal standards.

9.8.4. A low or high percent recovery for a blank does not require discarding the analytical data but it may indicate a potential problem with future analytical data. Internal standard recoveries are flagged if they are outside the recovery goals. Re-extraction of affected samples should be performed if signal-to-noise for any internal standard is less than 10:1.

9.9. Recovery Standard: Two recovery standards are used to determine the percent recoveries for the internal standards. The $^{13}C_{12}$ -1,2,3,4-TCDD is used to measure the percent recoveries of the tetra- and pentachlorinated internal standards while $^{13}C_{12}$ -1,2,3,7,8,9-HxCDD is used to determine the recovery of the hexa-hepta- and octachlorinated internal standards. $^{13}C_{12}$ -1,2,3,7,8,9-HxCDD also acts as a retention time reference for the unlabeled analog present in sample extracts. They are added to the final sample extract before HRGC/HRMS instrument analysis.

9.10. Recommended Corrective Actions and Troubleshooting Steps

- Verify satisfactory instrument performance.
- If possible, verify that no error was made while weighing the sample aliquots.
- Review the analytical procedures with the performing laboratory personnel.

10. CALIBRATION

10.1. On a daily basis, calibrate any balance to be used in accordance with SOP WS-QA-0041.

10.2. On a monthly basis, calibrate any autopipettor to be used in accordance with SOP WS-QA-0004.

11. PROCEDURE

11.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and is approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.2. Refer to SOP WS-ID-0009 for the preparation of stationary source samples.

11.3. Sample Pre-Treatment

11.3.1. Paper Pulp Sludges are generally air-dried and ground prior to extraction following Section 11.5. Because of the drying procedure, a Dean-Stark water separator is optional for extraction.

11.3.2. Fly Ash — Fly ash samples are pretreated with HCl prior to extraction by both soxhlet and separatory funnel techniques.

11.3.2.1. Weigh 2-10g of sample aliquot into a clean glass jar.

11.3.2.2. Add 1.0mL of the internal standard mixture with 2 mL of acetone.

11.3.2.3. Add 150 mL of 1N hydrochloric acid and shake for 4 hours.

11.3.2.4. If the sample reacts violently with acid, then allow the sample to equilibrate for 4 hours with no shaking.

11.3.2.5. Filter the contents of the jar through a glass fiber filter.

11.3.2.6. Extract the solids as per Section 11.5, omitting the daily internal standard spike for the samples.

11.3.2.7. Extract the aqueous filtrate as per Section 11.8, using 100 mL of toluene for the first shake, and 100 mL of hexane for subsequent shakes.

11.3.2.8. Concentrate the combined toluene solutions to near dryness on a rotary evaporator at 50°C. Proceed with Section 11.12 as necessary.

Note: As an option, a Soxhlet/Dean Stark extractor system may be used, with toluene as the solvent. No sodium sulfate is added when using this option.

11.4. Waste Dilution (Still-Bottom/Fuel Oil, and other solvent-miscible materials).

11.4.1. Weigh 1 g of the waste (organic liquids, fuel oils, and solids that will dissolve in a solvent) into a vial.

11.4.2. Add 40 mL of toluene (or other solvent if the material is not miscible/soluble in toluene). Shake gently to dissolve.

11.4.3. Remove a 4.0 mL aliquot (0.1g sample equivalent) and place in a culture tube. Add 1.0 mL of daily internal standard and 1.0 mL of cleanup recovery standard, and proceed to Section 11.12.

11.5. Soxhlet Extraction (Solids, Tissues, Sludges, Wipes)

11.5.1. Pre-extract the glassware by heating the flask until the toluene is boiling. When properly adjusted, 1-2 drops of toluene per second will fall from the condenser tip into the receiver. Extract the apparatus for a minimum of four hours.

WARNING: Open the chiller supply valves about 15 minutes before turning on the heating element and ensure that all of the condensors are cold before you turn the heating element on. Check all of the condensors about 15 minutes after starting the heating process to ensure that they are still cold and functioning properly. If this cleaning cycle is to be left unattended (e.g., overnight) the first chemist to arrive the next morning is to check all condensers to ensure that they are still cold and functioning properly.

11.5.2. After pre-extraction, cool and disassemble the apparatus.

11.5.3. If tissues requiring % Lipids are to be extracted, for each sample weigh the concentration vessel with label and boiling chips. Record the mass on the benchsheet. Refer to SOP WS-QA-0018 “Subsampling”, for instructions on how to homogenize and subsample the container of sample.

11.5.4. Weigh a well-mixed aliquot of each sample (10 g, unless otherwise specified) into a clean Soxhlet thimble. Record the mass to the nearest 0.01g. Use sodium sulfate for the batch QC (MB, LCS) for solids, and a mixture of 9 g sodium sulfate and 1 g canola oil for the batch QC for tissue matrices.

11.5.4.1. In the case of wipes, place the entire wipe sample into the Soxhlet apparatus (no thimble needed), including any liquid present with the sample. Use pre-cleaned wipes for the batch QC samples.

11.5.5. Place the thimble into a Soxhlet apparatus equipped with a Dean-Stark water separator.

11.5.6. Spike all samples with 1.0 mL of internal standard solution (2 pg/µL), for a final concentration of 200 pg/g (based on a 10 g sample).

11.5.7. Spike the LCS (and MS/MSD, if present) with 50 uL of native spike.

11.5.8. Reassemble the pre-extracted apparatus and add a fresh charge (250-300 mL) of toluene to the receiver and reflux flask.

11.5.9. Reflux 16 hours, with the solvent cycling at least 5 times per hour.

WARNING: Open the chiller supply valves about 15 minutes before turning on the heating element and ensure that all of the condensors are cold before you turn the heating element on. Check all of the condensors about 15 minutes after starting the heating process to ensure that they are still cold and functioning properly. If this cleaning cycle is to be left unattended (e.g., overnight) the first chemist to arrive the next morning is to check all condensers to ensure that they are still cold and functioning properly.

11.5.10. Drain the water from the receiver if the receiver fills with water. Check and drain when necessary.

Note: If the receiver holds 10 mL of liquid, and 20 g of an approximately 10% solid sample is being extracted, then approximately 9 mL of water will end up in the receiver. In this case, the receiver will not need to be emptied (insufficient liquid to overflow), but it should be checked. If the sample amount is 50, and the percent solids is still 10%, then 45 mL of water will end up in the receiver. In this case, frequent checking is required, and the receiver will need to be emptied at least 5 times.

11.5.11. After refluxing, allow the apparatus to cool.

11.5.12. If samples DO NOT require % lipids add 100 µL of tetradecane as a keeper to the round bottom flask.

11.5.13. Proceed to Section 11.17.

11.6. SoxTherm Extraction (Solids, Tissues, Sludges,Wipes)

11.6.1. Prior to loading samples, run the system through 2 cleaning cycles (approximately 1 hour each).

11.6.2. After pre-extraction, cool and disassemble the apparatus.

11.6.3. Weigh a well-mixed aliquot of each sample (10 g, unless otherwise specified) into a clean Soxhlet thimble. Record the mass to the nearest 0.01g. Use sodium sulfate for the batch QC (MB, LCS) for solids, and a mixture of 9 g sodium sulfate and 1 g canola oil for the batch QC for tissue matrices.

11.6.3.1. In the case of wipes, place the entire wipe sample into the Soxhlet apparatus (no thimble needed), including any liquid present with the sample. Use pre-cleaned wipes for the batch QC samples.

11.6.4. Place the thimble into the Soxtherm apparatus.

11.6.5. Spike all samples with 1.0 mL of internal standard solution (2 pg/µL), for a final concentration of 200 pg/g (based on a 10 g sample).

11.6.6. Spike the LCS (and MS/MSD, if present) with 50 uL of native spike.

11.6.7. Reassemble the pre-extracted apparatus and add a fresh charge (150 mL) of toluene to the apparatus.

11.6.8. Program the system to boil for 1 hour, and reduce the toluene volume by 70-90 mL (volume < volume of the thimble).

11.6.9. Continue the extraction for one hour fifteen minutes, reducing the toluene volume by another 15 mL.

11.6.10. After refluxing, allow the apparatus to cool.

11.6.11. Pour the samples into round bottom flasks, and if samples DO NOT require % lipids add 100 µL of tetradecane as a keeper to the round bottom flask.

11.6.12. Proceed to Section 11.17.

11.7. Extract Splitting (Wipes)

Wipe extracts prepared using either Soxhlet or shaking techniques are split prior to further workup, to permit an archive aliquot, or analysis by an additional method.

Once the extract has been concentrated using the rotovap or Turbovap, proceed as follows:

11.7.1. Add approximately 1 mL of hexane or toluene to rinse the sides of the round bottom flask. Using a pipette, withdraw the sample from the round bottom flask and transfer the liquid into a test-tube. Use additional amounts of solvents to rinse the flask. Transfer all the liquid into the test-tube. Ensure that all traces of sample in the round bottom flask have been thoroughly rinsed from all surfaces. Bring the sample volume to 8.0 mL or 10.0 mL (or appropriate volume) with the addition of rinse solvent.

11.7.2. Upon completion of the rinsing, cap the test tube and shake vigorously. Take ½ of each sample (or an appropriate amount as instructed by the client, program manager or department manager) and transfer to a culture tube. Archive the remaining sample for future use.

11.7.2.1. If only one analysis is required, then ½ of the sample is archived and the other half is analyzed.

11.7.2.2. If "N" analyses are required, then the extract is divided into "N+1" equal portions, so that one portion is archived, and a portion is used for each test.

11.8. Aqueous Samples (liquid/liquid extraction).

11.8.1. When setting up the glassware for a batch, for each sample label one separatory funnel and one 500 mL round-bottom flask with the sample ID.

11.8.2. Weigh the sample in the bottle on the top loading balance to the nearest centigram (0.01g), and record the mass.

11.8.3. For each sample, add 1 mL of daily internal standard solution into 2 mL of acetone. Add this solution to the sample in the separatory funnel. Each aliquot of spike mixture is added similarly.

11.8.4. Dissolve 50µL of the target analyte into acetone and add this mixture into the LCS container.

11.8.5. Pour the entire sample (approximately 1L) into a 2L separatory funnel that is labeled with the sample ID.

11.8.6. Add 100 mL methylene chloride to the sample bottle, seal, and shake for 30 seconds to rinse the inner surface. Transfer the solvent to the separatory funnel.

11.8.7. Create a blank and LCS by adding 1 L of laboratory reagent water to 2

additional separatory funnels. Add 100 mL methylene choride to each funnel.

11.8.8. To the LCS, add 50 µL of the precision and recovery standard dissolved into 2 mL of acetone.

11.8.9. Extract the samples by shaking each funnel for two minutes with periodic venting.

Warning: Separatory funnel extraction with methylene chloride is a high-risk activity. Pressure may build rapidly in the funnel. It should be vented after several seconds of shaking, and often enough to prevent build-up of pressure. Chemist performing separatory funnel extraction must wear a face shield over their safety glasses/goggles. Alternatively, the extraction can be performed behind a closed fume hood sash.

11.8.10. Allow the organic layer to separate from the water phase for a minimum of 10 minutes. If the emulsion interface between layers is more than one-third the volume of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation.

11.8.11. Repeat the extraction two additional times with methylene chloride.

11.8.12. Determine the original sample volume by re-weighing the sample bottle. Record the sample volume to the nearest centigram (0.01g).

11.8.13. Dry extract with sodium sulfate: Place glass wool in a precleaned filter funnel. Rinse glass wool with methylene chloride and load funnel with Na_2SO_4. Pour extract through Na_2SO_4 to remove water. Rinse Na_2SO with fresh methylene chloride and collect in round bottom flask.

11.8.14. Transfer the extract to a 500 mL round-bottom previously labeled with the sample ID, then add approximately 100 µL of tetradecane and concentrate on a rotary evaporator or TurboVap.

11.8.15. Perform macro-concentration as detailed in Section 11.17.

11.9. Aqueous Samples (solid phase extraction).

11.9.1. Weigh the sample in the bottle on the top loading balance to the nearest centigram (0.01g), and record the mass.

11.9.2. Create a blank and LCS by adding 1L of laboratory reagent water to 2 additional 1L bottles.

11.9.3. For each sample, add 1mL of daily internal standard solution in acetone.

Add this solution to the sample in the bottles. Each aliquot of spike mixture is added similarly.

11.9.4. To the LCS, add 50µL of the precision and recovery standard in acetone.

11.9.5. Prepare the C18 extraction discs by first soaking them in toluene for at least 5 minutes.

11.9.6. Assemble the filter holder and vacuum filtration flask and place the extraction disc onto the filter holder. Place a GF-F filter on top of the extraction disc. If the sample has a large amount of particulates a GF-D filter can be placed on top of the GF-F filter. Alternatively, a GMF-150 filter can be used in place of the two filters.

11.9.7. Place the filtering funnel onto the disc holder and clamp it in place.

11.9.8. Rinse the filter and discs with approximately 15mL of toluene and allow it to soak for about a minute. Apply vacuum and draw the toluene through the discs. Repeat the wash step using about 15mL of acetone. Apply vacuum and draw the acetone through the discs.

11.9.9. Rinse the filter and discs with approximately 15mL of methanol and allow it to soak for about a minute. Apply vacuum and draw the methanol through the discs, but **DO NOT ALLOW THE DISCS TO GO DRY**. If they do go dry, simply repeat the methanol rinse step, leaving a 1 – 2mm layer of solvent on top of the discs.

11.9.10. Rinse twice with about 50mL of reagent water, leaving a 1 – 2mm layer of water on the surface of the discs.

11.9.11. Pour the spiked method blank, LCS or sample into the reservoir and apply vacuum to begin the extraction. Adjust the vacuum such that the extraction takes approximately 10 minutes. Samples with large amounts of particulates may take much longer.

11.9.12. After most of the sample has been pulled through the discs, rinse the sample bottle with a few mLs of reagent water and add the rinse to the funnel. Rinse down the sides of the funnel with reagent water as well.

11.9.13. Allow the discs to dry, remove them from the holder and extract by soxhlet (11.5) or soxtherm (11.6) and proceed with cleanups.

11.9.14. Determine the original sample volume by re-weighing the sample bottle. Record the sample volume to the nearest centigram (0.01g).

11.10. Breaking Emulsions

There are several useful methods to decrease or eliminate emulsion in aqueous samples when extracting with methylene chloride. These methods may include stirring with a pipette to manually breakup the emulsions or to transfer the sample into centrifuge tubes and centrifuge at approximately 3000 RPM. The most useful method is to use a 10:1 $NaOH/H_2O$ solution to change the pH enough to disrupt the emulsion phase, which works 90% of the time. See Section 7.3.5 for reagent preparation.

11.10.1. Check the pH of the sample to verify that the pH is between 3 and 7. If the pH is greater than 7, consult the supervisor and client for instructions.

11.10.2. Pour approximately 100 mL of the 10:1 $NaOH/H_2O$ into a 1 L amber glass bottle (AGB).

11.10.3. Drain the sample with the emulsion from the 2 L separatory funnel into the 1 L AGB and let it stand.

11.10.4. Empty the aqueous waste into the LLE waste drum.

11.10.5. Pour the solution with methylene chloride back into the same 2 L separatory funnel and drain the methylene chloride phase through Na_2SO_4 into a 500 mL round-bottom flask.

11.10.6. Empty the aqueous waste into the LLE waste drum.

11.10.7. Proceed with macro-concentration (Section 11.17).

11.11. Filter/PUF Samples

11.11.1. Place the glass sleeve containing the PUF and the Quartz Fiber Filter into the pre-cleaned Soxhlet extractor charged with toluene.

11.11.2. Add 2 mL (4000 pg) of 1613/8290 daily Internal Standard solution to all samples and QC.

11.11.3. Add 50 uL of 1613/8290 Native Spike to the LCS.

11.11.4. Extract the samples and QC for a minimum of 16 hours.

11.11.5. Concentrate the extract from the round bottom flask with hexane and adjust the volume.

11.11.6. Transfer the extract from the round bottom flask with hexane and adjust the volume.

11.11.7. Split the extract 50:50 for analysis and archive.

11.11.8. Proceed to Section 11.12.

11.12. Extract Clean-Up

11.12.1. For all samples that are not air media, spike 1.0 mL of the Cleanup Recovery Standard (CRS) prior to any cleanup into the round bottom flasks containing the samples and QC Extracts (See also Section 9.7).

11.12.2. Proceed with further cleanups as dictated by the sample matrix and extract color. The "Option C" cleanup (Section 11.13) and the IFB Upper Column cleanup (Section 11.14) are applied to samples with high levels of interferences. The IFB column cleanup (Section 11.15) is applied to all samples.

11.13. Acid Partitioning ("Option C")

11.13.1. Use this clean up as needed on samples with high levels of interferences. Consult with a lead chemist or department manager to determine applicability.

11.13.2. Partition the extract in 50-125 mL of hexane against 40 mL concentrated H_2SO_4 in a separatory funnel. Shake for two minutes. Remove and discard the H_2SO_4 layer (bottom). Repeat the acid washing until no color is visible in the acid layer (perform a maximum of four acid washings).

Warning: Shaking with a concentrated caustic is a high-risk activity. Analyst must wear a face shield over safety glasses/goggles, or the shaking must take behind a closed hood sash.

11.13.3. Partition the extract against 50 mL of distilled H_2O. Shake for two minutes. Remove and discard the aqueous layer (bottom). Dry the extract by pouring it through a funnel containing anhydrous sodium sulfate and collect it in a round-bottom flask. Rinse the sodium sulfate with two 15 mL portions of hexane, add the rinsates to the flask, and concentrate the hexane solution to near dryness on a rotary evaporator (35°C water bath), making sure all traces of toluene (when applicable) are removed. (Use of blow-down with an inert gas to concentrate the extract is also permitted.) The DI H_20 partition is applied only as samples warrant it at the discretion of the analyst.

11.14. IFB Upper Column Cleanup

11.14.1. Use this clean up as needed on samples with high levels of interferences. Consult with a lead chemist or department manager to determine applicability.

11.14.2. Set up the upper of the two chromatography columns as depicted in Figure 2.

The column (20 mm diameter) is packed in this order: a glass wool plug, 2 g activated silica gel, 4 g Acid silica gel, 2 g activated silica gel, and 1 g sodium sulfate.

11.14.3. Pre-rinse the column with 20 mL hexane, and discard the rinsate.

11.14.4. Add extract to the column. Rinse extract vessel 2 times with 1 mL each of hexane and add to column.

11.14.5. Elute 60 mL hexane directly onto acid silica column (upper column).

11.14.6. Collect the eluate, and concentrate before proceeding with the IFB cleanup (Section 11.15).

11.15. IFB Column Cleanup

Most samples will undergo this cleanup, either direction following concentration on the rotovap, or following the cleanup in Section 11.13 (Option C) or Section 11.14 (IFB Upper Column).

11.15.1. Set up two chromatography columns as depicted in Figure 2. The upper column (20 mm diameter) is packed in this order: a glass wool plug, 2 g activated silica gel, 4 g Acid silica gel, 2 g activated silica gel, and 1 g sodium sulfate. The lower column (15 mm diameter) is packed in this order: a glass wool plug, 6 g acid alumina, and 1 g sodium sulfate.

11.15.2. Pre-rinse each column with 20 mL hexane, and discard the rinsate.

11.15.3. Put one column above the other.

11.15.4. Add extract to the top column (silica column). Rinse extract vessel 2 times with 1 mL each of hexane and add to column.

11.15.5. Elute 60 mL hexane directly onto acid silica column (upper column).

11.15.6. Discard upper column.

11.15.7. Elute lower column with 10 mL of 20% methylene chloride/hexane. Discard in proper waste stream.

11.15.8. Elute lower column with 30 mL of 65% methylene chloride/hexane. Save and collect in culture tube.

11.15.9. Proceed with additional cleanups as necessary.

11.16. Carbon Column Clean-up (D2 Column)

Prepare an activated Carbon & Silica Gel column as described in below. Refer to the diagram in Figure 3 as well.

11.16.1. Push a glasswool plug down to the 3 inch mark in a pre-cut D2 column.

11.16.2. Add 1 g of 5% activated carbon/silica. Top with a glasswool plug.

11.16.3. With the column oriented with "A" on the top (and the carbon on the lower end of the column), pre-elute with 5 mL 1:1 methylene chloride :cyclohexane.

11.16.4. Discard pre-eluates.

11.16.5. Invert the column so that the column is oriented with the "B" on the top and pre-elute with 3 mL of 1:1 methylene chloride.

11.16.6. Dilute the extract to 1 mL with hexane and transfer to the column (still oriented in the "B" direction).

11.16.7. Rinse sample vial onto the column with 2 x 2 mL 1:1 methylene chloride:cyclohexane.

11.16.8. Elute with 6 mL 1:1 methylene chloride :cyclohexane

11.16.9. Elute with 5 mL 75:25 methylene chloride:methanol

11.16.10. Discard eluates.

11.16.11. Turn the column over (so that the "A" end is on top), and elute with 30 mL of toluene. Collect this eluate.

11.16.12. Concentrate to NEAR dryness using the Rotovap (Section 11.17) or Turbovap (Section 11.18), then proceed to the recovery standard step (Section 11.19).

11.17. Macro-concentration (Rotary Evaporator)

Concentrate the extracts in separate round bottom flasks on rotary evaporator.

11.17.1. Assemble the rotary evaporator according to manufacture's instructions, and warm the water bath. On a daily basis, preclean the rotary evaporator by solvent rinsing. Between samples, 2-3 mL rinses of toluene followed by a 2-3 mL rinse of hexane should be rinsed down the feed tube into a waste beaker.

Rotovap Conditions		
Solvent	**Bath Temperature (C)**	**Vacuum Setting (PSI)**
Toluene	80	25
Hexane	65	15
Methylene Chloride	70	No vacuum applied

11.17.2. Attach the round bottom flask containing the sample extract to the rotary evaporator. Slowly apply vacuum to the system, and begin rotating the sample flask.

11.17.3. Lower the flask into the water bath and adjust the speed of rotation and the temperature as required. At the proper rate of concentration, the flow of solvent into the receiving flask will be steady, but no bumping or visible boiling of the extract will occur.

NOTE: If the rate of concentration is too fast, analyte loss may occur.

11.17.4. For samples requiring % Lipids analysis:

11.17.4.1. Concentrate until the toluene has been completely removed. Add approximately 25 mL hexane and concentrate to ensure that only the lipids are present.

11.17.4.2. Dry the concentration vessel and let stand at room temperature. Weigh the vessel and record on the benchsheet.

11.17.4.3. Calculate % lipids as follows:

$$\%\ \text{Lipids} = \frac{\text{Final Vessel Mass - Initial Vessel Mass}}{\text{Sample Size}} \times 100\%$$

11.17.5. Proceed to extract cleanups, or transfer to a micro concentration vial for the recovery standard step (Section 11.19).

11.18. Micro-concentration (Turbovap)

Concentrate the extracts in 35 mL culture tubes in a turbo-evaporator. The turbo-evaporator model that the laboratory uses can hold up to 50-35 mL culture tubes. Other turbo-evaporator models can be used that may or may not have the same culture tube sizes and/or capacity. Adjust temperature according to solvent (65ºC for toluene and 45ºC for hexane or hexane/ methylene chloride mixtures)

11.18.1. The evaporating times are dependent on sample volume and solvent. The following are examples and can change from sample to sample. Each sample should be checked in intermittent intervals to make sure samples do not go dry.

11.18.2. When evaporating 30 mL toluene, it will normally take approximately 30-50

minutes with the temperature setting described above.

11.18.3. When evaporating 30 mL hexane/ methylene chloride, it will normally take approximately 20-30 minutes with the temperature setting described above.

11.18.4. For samples requiring % Lipids analysis refer to Section 11.17.4.

11.18.5. Proceed to extract cleanups, or transfer to a micro concentration vial for the recovery standard step (Section 11.19).

11.19. Recovery Standard

11.19.1. Transfer extracts to a micro concentration vial (test tubes and other small vessels may also be used)

11.19.2. With a stream of dry, purified nitrogen, reduce the extract volume to approximately 100 µL.

11.19.3. Add 20 µL of the recovery standard solution (Table 2).

11.19.4. With a stream of dry, purified nitrogen, reduce the extract volume to 20 µL.

11.19.5. Transfer the extract to an autoinjection vial and store in the dark at room temperature.

11.19.6. A smaller final volume can be used to decrease the detection limit upon client approval.

11.19.7. A larger final volume can be use to decrease potential matrix interferences, if the column and acid cleanups were unsuccessful.

11.20. Sample Dilution Procedure

11.20.1. Simple dilutions: Dilutions from 2X to 50X can be achieved without respiking the final extract. The calculation to determine the final extract concentration is as follows:

$$\text{Final Conc. of Extract} = \frac{(\text{Conc. of original extract}) \text{ x } (\text{Amount of aliquot taken})}{(\text{Volume of diluted extract})}$$

Ex:
$$\frac{(10\,\text{g}) \text{ x } (2\,\mu\text{L})}{(20\,\mu\text{L}) \text{ x } (100\,\mu\text{L})} = \frac{1\,\text{g}}{100\,\mu\text{L}} \text{ FV}$$

Record the final sample concentration on the extract label.

11.20.2. Complex dilution requiring respiking of IS and RS:

Dilutions greater than 50x must be done by diluting and respiking the extract with IS and RS. This procedure may require serial dilution to be performed. If this procedure is done, then the sample size must be adjusted to reflect the aliquot taken.

Ex. 100X dilution (original sample with 10 g/20 µL final volume)

Take a 2 µL aliquot (1/10 of original sample) and add 18 µL of solvent keeper. Take a 2 µL aliquot of the dilution (1/100 of the original sample), respike with 1 mL IS and 20 µL RS, reduced to 20 µL FV.

Record the final sample concentration of the extract label.

12. CALCULATIONS/DATA REDUCTION

12.1. Not applicable

13. METHOD PERFORMANCE

It must be documented that all applicable system performance criteria specified were met before analysis of any sample is performed. .

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

14.1. The use of Roto-vaps and Turbo-vaps rather than Kuderna-Danish reduction allows extraction solvents to be collected and disposed of rather than released to the atmosphere.

14.2. Toluene, which is a less hazardous solvent, has been substituted for benzene as an extraction solvent.

14.3. The use of SoxTherm extraction rather than soxhlet extraction, when appropriate, reduces the volume of solvent used.

14.4. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards that must be discarded.

14.5. All waste will be disposed of in accordance with Federal, State, and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment.

14.6. Do not allow waste solvent to vent into the hoods. All solvent waste is stored in capped containers unless they are being filled.

14.7. Transfer waste solvent from collection cups (tri-pour and similar containers) to jugs and/or carboys as quickly as possible to minimize evaporation.

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Extracted aqueous/leachate samples contaminated with methylene chloride are collected at the fume hood in a 5-gallon or smaller carboy. If the samples are not at a

neutral pH, add small quantities of sodium bicarbonate to bring the waste to neutral. Stir well. Once neutralized, immediately pour the carboy contents into a blue plastic LLE drum in the H3 closet. When full to between two and six inches of the top, or after no more than 75 days, move the LLE drum to the waste collection area for shipment.

15.2. Extracted soil samples and thimbles, extracted PUF filters, XAD-2 resin, paper funnel filters, glass wool, sodium sulfate, assorted disposable glassware, fish/crawfish or similar materials, silica gel, alumina, and carbon from column clean-ups, contaminated with various solvents and eluates. Dump the materials into a orange contaminated lab trash bucket. When the bucket is full or at the end of the day, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.3. Flammable solvent and methylene chloride waste generated during glassware and sodium sulfate cleaning. Solvent waste collected during roto-vap/turbo-vap reduction of extracted samples. Collect the waste solvents in tripours during use. Empty the tripours into a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the steel solvent drum in the H3 closet. When full to between two and six inches of the top, or after no more than 75 days, move the steel drum to the waste collection area for shipment.

15.4. Assorted flammable solvents and methylene chloride waste generated during quartz fiber filter preparation, PUF adsorbent preparation, XAD-2 resin preparation, PUF/XAD-2 cartridge preparation, glassware rinsing and sodium sulfate pre-rinsing.. Waste solvents and methylene chloride collected during roto-rap/turbo-vap reduction of extracted samples. Collect the waste solvents in tripours during use. Empty the tripours into a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the steel drum in the H3 closet. When the drum is full to between two and six inches of the top, or after no more than 75 days, move the steel drum to the waste collection area for shipment.

15.5. Contaminated sulfuric acid used during extract cleanup. Collect the used sulfuric acid in empty, 2.5-liter, plastic coated jars. When full or after one year, whichever comes first, transfer these jars to the waste collection area for shipment.

15.6. Contaminated distilled water used during extract cleanup. Collect the contaminated water in a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the plastic LLE drum in the H3 closet. When full to between two and six inches of the top, or after no more than 75 days, move the plastic drum to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update IV. Method 8290A Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by high-Resolution Mass Spectrometry February 2007.

16.2. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update III. Method 8290 Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by high-Resolution Mass Spectrometry September 1994.

16.3. SW846, Test Methods for Evaluating Solid Waste, Third edition, Update III. Method 0023A, Sampling Method for Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans Emissions from Stationary Sources. December 1996.

16.4. Compendium Method TO-9A “Determination of Polychlorinated, Polybrominated, and Brominated, Cholorinated Dibenxo-p-dioxins and Dibenzofurans in Ambient Air”, EPA compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, second edition, January 1997.

16.5. Protocol for the Analysis of 2,3,7,8-TCDD by HRGC/HRMS". J. S. Stanley and T. M. Sack, EPA 600/4-86-004.

16.6. “Safety in Academic Chemistry Laboratories", American Chemical Society Publication, Committee on Chemical Safety (3rd Edition, 1979.)

16.7. “Carcinogens - Working with Carcinogens". Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control. National Institute for Occupational Safety and Health. Publication No. 77-206, August 1977.

16.8. "OSHA Safety and Health Standards, General Industry", (29 CFR 1910) Occupational Safety and Health Administration, OSHA 2206 (revised January 1976).

17. METHOD MODIFICATIONS

17.1. Deviations from EPA 8290 and 8290A.

17.1.1. Tetradecane instead of nonane is used as the final solvent to increase the stability of extracts and standards. Tetradecane is less volatile than nonane. Loss of analyte as a result of solvent incompatibility is monitored through recovery checks and calibration acceptance criteria.

17.1.2. Extract clean-ups are performed at the discretion of the analyst when interferences are observed. Then, the analyst should select the clean-up procedure appropriate to the interferent.

17.1.3. Section 7.4.6.4 of Method 8290 indicates that extracts should be transferred with hexane, then toluene. Toluene is used to transfer extracts to maintain compound solubility and minimize analyte loss.

17.1.4. Section 7.5.1.2 of Method 8290 specifies that a NaCl solution should be used for partitioning. Instead, the laboratory uses laboratory water only. NaCl is used to break up emulsions that may form. An analyst may use NaCl, NaOH, or any mechanical means to break up an emulsion.

17.1.5. Section 7.5.3 of Method 8290 specifies that hexane is used as a column elution solvent. The laboratory uses cyclohexane to achieve better and more reproducible separation of the target analyte from the interferent.

17.1.6. Carbon columns are packed with silica gel in place of celite. Elution solvents are changed accordingly. (SOP Section 11.4; Method 8290 Section 7.5.3.2, 8290A Section 7.3.6.).

17.2. Modifications from TO-9A method

17.2.1. Quartz Fiber Filters are cleaned by Soxhlet extraction with methylene chloride, not baked at 400 degrees C for 5 hours.

17.2.2. The PUF material may be pre-cleaned with methylene chloride or other appropriate solvent. The PUFs are not reused.

17.2.3. The $^{37}Cl_4$-2,3,7,8-TCDD surrogate is present at varying levels in the calibration curve (0.5-200 pg/ µL).

17.2.4. Samples are extracted with toluene not benzene.

17.2.5. Concentration is performed by rotary evaporation not Kuderna-Danish.

17.2.6. All cleanup procedures are optional and applied based on the analyst's discretion.

17.2.7. The laboratory uses 2 labeled recovery standard for the quantitation of labeled internal standards.

17.2.8. The final volume is adjusted to 20 µL in tetradecane.

17.2.9. Calibration and quantitation are performed in accordance to this SOP.

18. ATTACHMENTS

18.1. Table 1 - Types of Matrices

18.2. Table 2 - Composition of Sample Fortification and Recovery Standard Solutions.

18.3. Table 3 - The Seventeen 2,3,7,8-Substituted PCDD and PCDF Congeners

18.4. Figure 1 - Analysis Flowchart

18.5. Figure 2 — IFB column cleanup

18.6. Figure 3 — D2 Column cleanup

18.7. Appendix A - Periodic Wipe Test Performance

19. REVISION HISTORY

19.1. WS-IDP-0005, Revision 1.5, Effective 12/21/2012

19.1.1. Clarified extraction procedure by revising Section(s) 11.8.1- 11.8.4 and adding an extra extraction step (Section 11.8.3).

19.1.2. Editorial revisions. .

19.2. WS-IDP-0005, Revision 1.4, Effective 03/20/2012

19.2.1. Appended to Section 2.2: “This method can also use solid phase extraction (SPE), however, Test America West Sacramento is in the developmental stages for this extraction type and is not currently certified for its use.”

19.2.2. Editorial changes.

19.3. WS-IDP-0005, Revision 1.3., Effective 06/10/2011

19.3.1. Added Section 11.9: Aqueous Samples (Solid Phase Extraction).

19.3.2. Editorial revisions.

19.4. WS-IDP-0005, Revision 1.2, Effective 2/11/2011

19.4.1. Added benzene to Section 5.2 Table..

19.4.2. Editorial revisions.

19.5. WS-IDP-0005, Revision 1.1, Effective 2/12/2010

19.5.1. Section 11.2 – updated SOP reference from SAC-ID-0009 to WS-ID-0009.

19.5.2. Section 11.6.1 – changed: “Prior to loading samples, run the system through

a cleaning cycle (approximately 3 hours)" to "(approximately 1 hour)."

19.5.3. Section 11.6.8 – changed "…fresh charge (140 mL) of toluene…" to "…fresh charge (150 mL) of toluene….".

19.5.4. Section 11.16.1 – inserted in Table "No vacuum applied" under vacuum setting (PSI) for solvent Methylene chloride.

19.6. WS-IDP-0005, Revision 1, Effective 10/2/2008

19.6.1. Added 8290A references.

19.6.1.1. Extract and standard storage.

19.6.1.2. Removal of MS/MSD.

19.6.2. Updated to TestAmerica format.

19.6.3. Separated the analytical steps from the preparation steps, this SOP is concerned only with the sample preparation.

19.7. WS-ID-0005, Revision 6.7, Effective 8/21/2008

19.7.1. Changed the word "toluene" to "acetone" in 7.11.2.

19.8. WS-ID-0005, Revision 6.6, Effective 4/9/2008

19.8.1. Added South Carolina rule to prepare an MS/MSD with every batch.

19.8.2. Modified to include extraction and analysis of ambient air samples collected in filter/PUF material.

TABLE 1

Types of Matrices, Sample Sizes and 2,3,7,8-TCDD-Based Method Calibration Limits (Parts per Trillion)

	Water	Soil Sediment Paper Pulp	Fly Ash	Human/ Fish Tissue	Adipose Tissue	Sludges, Fuel Oil	Still-Bottom	Ambient or Source Samples
Lower MCL(a)	0.01	1.0	2.0	1.0	2.0	10	20	40
Upper MCL(a)	4.0	400	400	400	400	2000	4000	8000
Weight (g)	1000	10	10	10	10	2.0	1.0	1 sample
IS Spiking Levels (ng)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0
Final Extract Volume (μL)	20	20	20	20	20	20	20	20

(a) For other congeners, multiply the values by 1 for TCDF, by 5 for PeCDD/PeCDF/HxCDD/HxCDF/HpCDD/HpCDF, and by 10 for OCDD/OCDF.

TABLE 2

Composition of the Sample Fortification and Recovery Standard Solutions

Analyte	Semple Fortification Solution Concentration pg/μL; Solvent: Isooctane	Recovery Standard Solution Concentration pg/μL; Solvent: Tetradecane
$^{13}C_{12}$ -2,3,7,8-TCDD	2[a], 100[c]	--
$^{13}C_{12}$ -2,3,7,8-TCDF	2[a], 100[c]	--
$^{13}C_{12}$ -1,2,3,4-TCDD	--	100
$^{13}C_{12}$ -1,2,3,7,8-PeCDD	2[a], 100[c]	--
$^{113}C_{12}$ -1,2,3,7,8-PeCDF	2[a], 100[c]	--
$^{13}C_{12}$ -1,2,3,6,7,8-HxCDD	2[a], 100[c]	--
$^{13}C_{12}$ -1,2,3,4,7,8-HxCDF[d]	2[a], 100[c]	--
$^{113}C_{12}$ -1,2,3,7,8,9-HxCDD	--	100
$^{13}C_{12}$-2,3,7,8-TCDD[b][c]	0.8[b],100[c]	
	100[c]	
$^{13}C_{12}$ -2,3,4,7,8-PeCDF[c]	100[c]	
$^{13}C_{12}$ -1,2,3,6,7,8-HxCDF[c][d]	100[c]	
$^{13}C_{12}$ -1,2,3,4,7,8-HxCDD[c]	100[c]	
$^{13}C_{12}$ -1,2,3,4,7,8,9-HpCDD[c]	100[c]	
$^{13}C_{12}$ -1,2,3,4,6,7,8-HpCDD	2[a], 100[c]	--
$^{13}C_{12}$ -1,2,3,4,6,7,8-HpCDF	2[a], 100[c]	--
$^{13}C_{12}$ -OCDD	4[a], 200[c]	--

(a) Standard 8290, Method 23, Method 0023A, TO9 and TO9A Sample Fortification Solution concentrations
(b) Method TO9 and TO9A surrogate concentrations
(c) Method 23 and Method 0023A surrogate concentrations
(d) $^{13}C_{12}$ -1,2,3,6,7,8-HxCDF is used as a Sample Fortification Solution and $^{13}C_{12}$-1,2,3,4,7,8-HxCDF is used as a surrogate solution in Method 23 and Method 0023A

TABLE 3

The Seventeen 2,3,7,8-Substituted PCDD and PCDF Congeners

PCDD	PCDF
2,3,7,8-TCDD(*)	2,3,7,8-TCDF(*)
1,2,3,7,8-PeCDD(*)	1,2,3,7,8-PeCDD(*)
1,2,3,6,7,8-HxCDD(*)	2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDD	1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDD(+)	1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDD(*)	1,2,3,4,7,8-HxCDF(*)
1,2,3,4,5,6,7,8-OCDD(*)	2,3,4,6,7,8-HxCDF
	1,2,3,4,6,7,8-HpCDF(*)
	1,2,3,4,7,8,9-HpCDF
	1,2,3,4,5,6,7,8-OCDF

(*)The ^{13}C -labeled analog is used as an internal standard.
(+)The ^{13}C -labeled analog is used as a recovery standard.

FIGURE 1 — Flowchart of Process

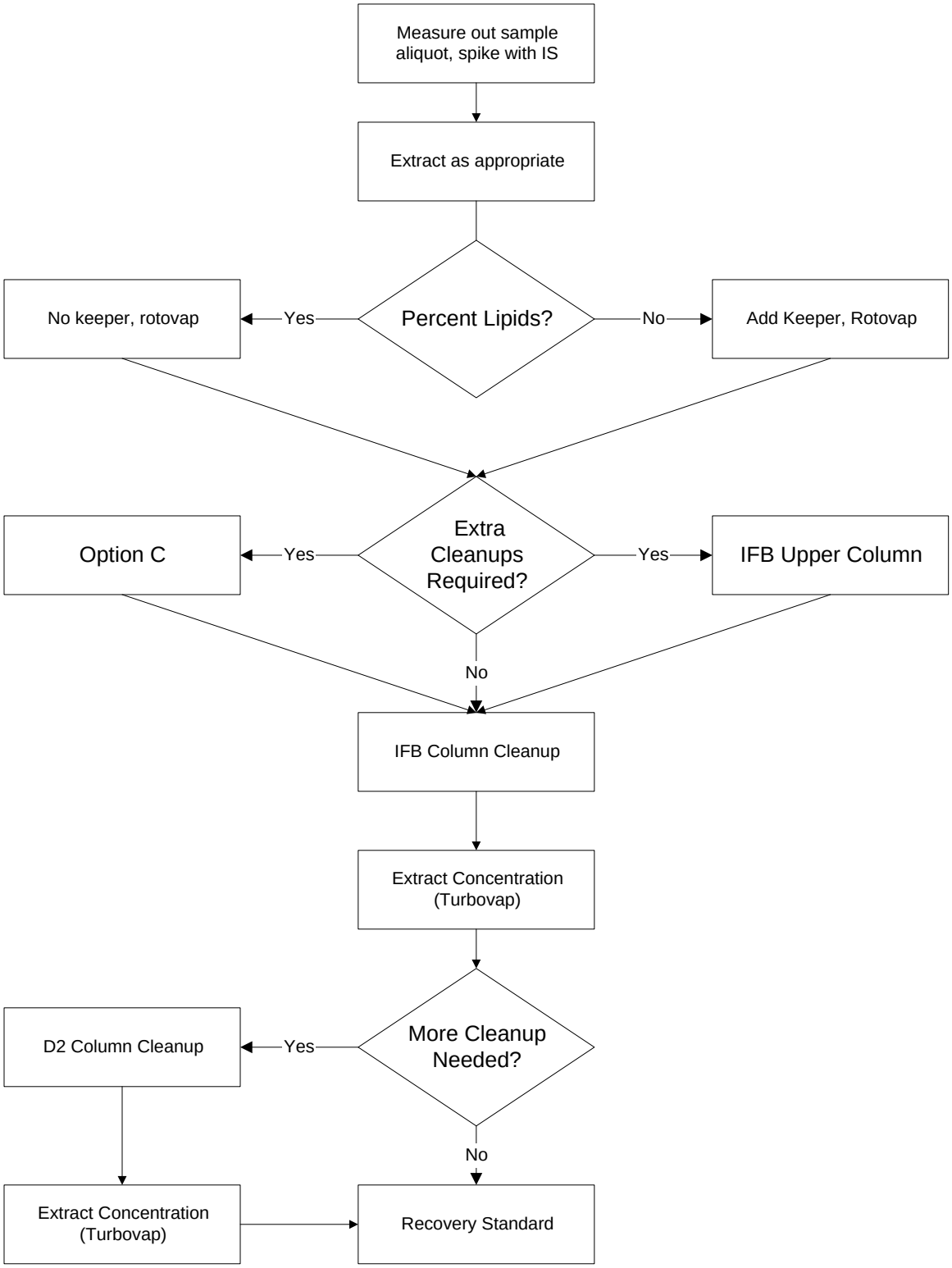


Figure 2 – Diagram of IFB Column Cleanup

Use 20 mm column for top column (IFB Column)
Use 16 mm column for bottom column* (Acid Alumina)
Note: Upper and lower columns are piggy backed for IFB cleanup, upper column only can be used for additional cleaning.

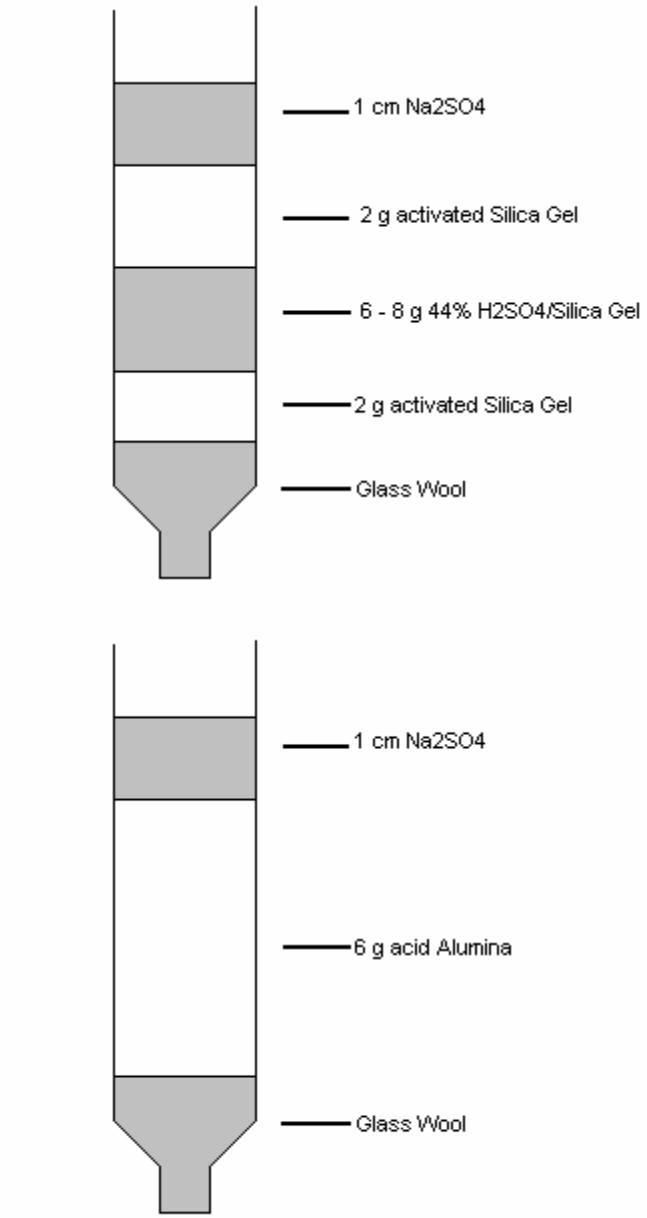
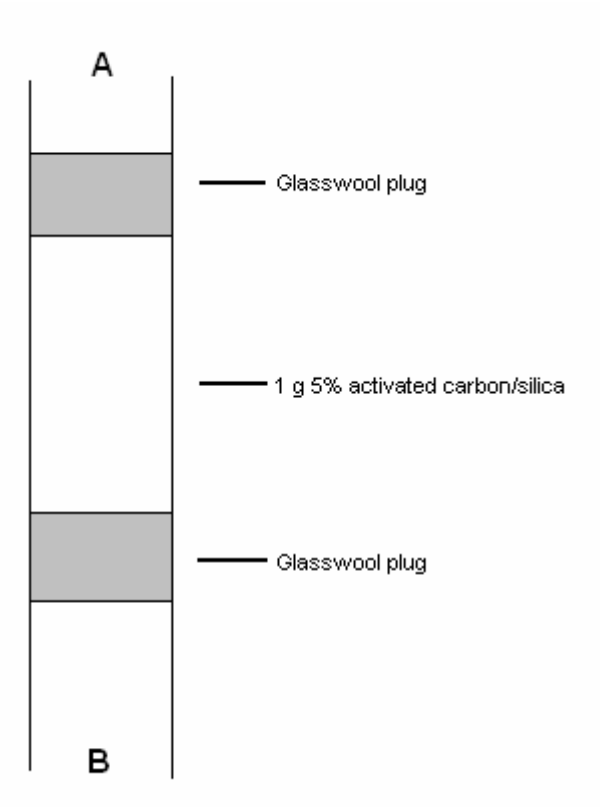


Figure 3— D2 Carbon Column:



APPENDIX A — Screening the Laboratory for 2,3,7,8 Congeners

This procedure is designed for the periodic evaluation of potential contamination by 2,3,7,8-substituted PCDD/PCDF congeners of the working areas inside the laboratory.

PERFORMING WIPE TEST
Perform the wipe tests on surface areas of two inches by one foot with laboratory wipers saturated with distilled-in-glass acetone or appropriate solvent using a pair of clean stainless steel forceps. Use one wiper for each of the designated areas. Combine the wipers to one composite sample in an extraction jar containing 200 mL distilled-in-glass hexane. Place an equal number of unused wipers in 200 mL hexane and use this as a control.

SAMPLE PREPARATION
Close the jar containing the wipes and 200 mL hexane and extract for 20 minutes using a wrist-action shaker. Use an appropriate means to reduce the volume to approximately 1.0 mL. Put through an alumina column to clean up potential interfering compounds. Add appropriate amount of recovery standard.

EXTRACT ANALYSIS
Concentrate the contents of the vial to a final volume of 20 µL (either in a minivial or in a capillary tube). Inject 2 µL of each extract (wipe and control) onto a capillary column and analyze for 2,3,7,8-substituted PCDDs/PCDFs as specified in the analytical method Section 11 (this exhibit). Perform calculations according to Section 12 (this exhibit).

REPORTING FORMAT
Report the presence of 2,3,7,8-substituted PCDDs and PCDFs as a quantity (pg or ng) per wipe test experiment (WTE). Under the conditions outlined in this analytical protocol, a lower limit of calibration of 25 pg/WTE is expected for 2,3,7,8-TCDD. A positive response for the blank (control) is defined as a signal in the TCDD retention time window at any of the masses monitored which is equivalent to or above 8 pg of 2,3,7,8-TCDD per WTE. For other congeners, use the multiplication factors listed in Table 1, footnote (a) (e.g., for OCDD, the lower MCL is 25 x 5 = 125 pg/WTE and the positive response for the blank would be 8 x 5 = 40 pg). Also, report the recoveries of the internal standards during the simplified cleanup procedure.

FREQUENCY OF WIPE TESTS
Wipe tests should be performed when there is evidence of contamination in the method blanks.

CORRECTIVE ACTION
An upper limit of 25 pg per TCDD isomer and per wipe test experiment is allowed. (Use multiplication factors listed in footnote (a) from Table 1 for other congeners.) This value corresponds to the lower calibration limit of the analytical method. Steps to correct the contamination must be taken whenever these levels are exceeded. To that effect, first vacuum the working places (hoods, benches, sink) using a vacuum cleaner equipped with a high-efficiency

particulate absorbent (HEPA) filter and then wash with a detergent. A new set of wipes should be analyzed before anyone is allowed to work in the dioxin area of the laboratory.

The test results and the decontamination procedure must be reviewed with EH&S.

Title: Acid Digestion Of Aqueous Samples by SW846 [Methods 3005A, 3010A]

Approvals (Signature/Date):

David Allameh 10/23/12 Technical Manager Date	Joe Schairer 10/23/12 Health & Safety Manager / Coordinator Date
Douglas Weir 10/26/12 Quality Assurance Manager Date	Karla Buechler 11/1/12 Laboratory Director Date

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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation of aqueous samples for the analysis of metals by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP – method 6010B), and Inductively Coupled Plasma Mass Spectrometry (ICPMS – method 6020) using SW846 3005A/3010A sample preparation protocols.

1.2. This SOP provides procedures applicable to the preparation of total recoverable, dissolved, and total metals in ground water, surface water, saline water, and wastewater. It also applies to samples prepared by TCLP extraction.

1.3. Tables I and II show a list of the analytes that are analyzed at the West Sacramento facility and that are evaluated relative to method performance per NELAC criteria.

2. SUMMARY OF METHOD

2.1. Method 3005A is applicable to the preparation of total recoverable metals and dissolved metals by ICP and ICPMS. A representative aliquot of sample is heated with nitric and hydrochloric acids and substantially reduced in volume. The digestate is filtered (if necessary) and diluted to the original volume.

2.2. Method 3010A is applicable to the preparation of total metals for ICP analysis. A representative aliquot of sample is refluxed with nitric acid. After the digestate has been reduced to a low volume, it is refluxed with hydrochloric acid, filtered (if necessary) and brought up to the original volume.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

3.3. Dissolved Metals: Metals present in a sample after passing through a 0.45 um membrane filter. The sample should not be preserved prior to filtration. Once filtered the sample must be preserved to pH <2 with the addition of concentrated nitric acid.

3.4. Total Metals: metals present in an unfiltered, preserved sample followed by more aggressive digestion with nitric and hydrochloric acids (method 3010A).

3.5. Total Recoverable Metals: metals present in an unfiltered or dissolved sample following treatment with hot, dilute acid (method 3005A).

4. INTERFERENCES

4.1. There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include metallic or metal-containing lab ware, wearing improper gloves, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2. The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Attachment 4 for additional contamination control guidelines.

4.3. Boron and silica from the glassware will migrate into the sample solution during and following sample processing. For critical low level determinations of boron and silica, only quartz and/or plastic labware should be used.

4.4. Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents and other matrices may not be digested using these methods if they are not soluble with acids. If physical interferences are present, they should be documented.

4.5. Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.6. Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs the sample must be re-prepared. Antimony is easily lost by volatilization from hydrochloric acid media.

4.7. Precipitation of silver chloride (AgCl) may occur when chloride ions and high concentrations of silver (i.e., greater than 1 mg/L) are present in the sample.

4.8. Specific analytical interferences are discussed in each of the determinative methods.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toes, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Vinyl gloves provide adequate protection against the chemicals and reagents typically used during this process. However, if any organic solvents are used, or any sample matrix contains organic solvents, only nitrile gloves should be used.

5.1.2. The use of vacuum systems during filtration presents the risk of imploding glassware. All glassware used during vacuum operations must be thoroughly inspected prior to each use. Glass that is chipped, scratched, cracked, rubbed or marred in any manner must not be used under vacuum. It must be removed from service and replaced.

5.1.3. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.1.4. The acidification of samples containing reactive materials may result in the release of toxic gasses, such as cyanides or sulfides. Acidification of samples must be done in a fume hood.

5.1.5. When digesting samples on a hot plate or digestion block, heat protective gloves and/or hot tongs must be used when handling containers. Ensure that digestion containers are arranged safely and are not overcrowded.

5.1.6. Filtering, rinsing, and adjusting the volume of samples (when necessary) creates a significant risk of ergonomic injuries due to repetition and use of excessive force. Analysts performing these tasks must ensure that they do not perform any single task like this for more than 30 minutes without taking an ergonomic break or working on a different task. Analysts with smaller hands should ensure that they use 500 mL squirt bottles rather than 1 liter bottles, or use varying techniques (other than squirt bottles) for rinsing and volume adjustment when there are numerous samples to be processed.

5.1.7. Always carry bulk concentrated acid bottles in appropriate impact proof containers.

5.1.8. Acid washing of glassware is classified as a high-risk activity. A face shield must be worn over safety glasses or safety goggles during this process.

5.1.9. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled.

5.1.10. Exposure to chemicals must be maintained **as low as reasonably achievable**; therefore all samples must be opened, transferred, prepared, digested and cooled in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.11. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Digestion block capable of maintaining a temperature at approximately 95°C.

6.2. Calibrated thermometers that cover a temperature range of 0-200°C.

6.3. Disposable graduated block digestion tubes.

6.4. Whatman No. 41 filtration paper.

6.5. Bottle-top dispensers.

6.6. Adjustable air displacement pipettes.

6.7. pH indicator strips (pH range 0 - 14).

6.8. Polyethylene storage bottles.

6.9. Vacuum flask with filtration assembly.

6.10. Vacuum pump.

6.11. 0.45 um membrane filters.

7. REAGENTS AND STANDARDS

7.1. Use reagent grade chemicals in all tests. "Certificates of Analysis" should be supplied with all chemicals purchased. If not supplied, contact the vendor. When received, label the certificate and the reagent container with the receipt date. Reagent containers also need to be labeled with the opened and expiration dates.

7.2. Reagent water is produced by a Millipore nanopure system (SOP WS-QA-0014). Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.3. Laboratory Control Sample (LCS) and matrix spike (MS) solutions are purchased as certified custom solutions (Tables I, II). All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem. All stock standards must be labeled with the date of receipt and the date the standard is opened.

7.4. The LCS and MS samples must contain all the elements designated for analysis in each batch of samples. If a non-routine element is required that is not contained in the custom solution, the lab must purchase a solution from a designated vendor that will cover the additional analyte(s) of interest and provide for a final spike concentration that is appropriate to the determinative method.

7.5. Nitric acid, concentrated: Analytical reagent grade

7.6. Hydrochloric acid, concentrated: Analytical reagent grade

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2. Samples submitted for "total recoverable" or "total" metals analysis should be preserved in the field to a pH <2 with the addition of HNO_3 after sampling. Prior to sample preparation every sample must be tested for proper preservation using pH paper.

8.3. For dissolved metals analysis, the samples should be filtered through a 0.45 um filter prior to preservation. Filtration must be done in the field or within 24 hours of collection. For filtration done by the laboratory the sample must be preserved with HNO_3 immediately following filtration.

Note: If a sample being analyzed for dissolved metals is found to contain sediment the analyst should contact their supervisor or group leader. The client should be notified of the problem to decide how to treat the sample.

9. QUALITY CONTROL

9.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A batch must be prepared within the same time frame. A method blank (MB) and a laboratory control sample (LCS) or duplicate control sample (LCS/LCSD) must be prepared as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/SD), or in some instances a sample/sample duplicate. An analysis batch must include all QC samples, however they do not contribute to the maximum of 20 samples. See policy WS-PQA-003 of the Quality Control Program for more details.

9.2. One method blank (MB) must be prepared for every 20 samples. A method blank consists of reagent water processed through all of the steps, and at the same time as the associated samples. If a method blank exceeds +/- the reporting limit for a given analyte than the samples associated with that batch must be re-prepared. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo. For samples requiring laboratory filtration and preservation, the method blank must also be filtered and preserved. See policy WS-PQA-003 of the Quality Control Program for further details.

9.3. A laboratory control sample (LCS) must be prepared for every 20 samples. A LCS consists of reagent water spiked with the analytes of interest and processed through all of the steps, and at the same time as the associated samples. If a LCS is outside of percent recovery acceptance criteria, all of the samples associated with that LCS must be re-prepared except when a LCS exhibits high recovery. For such a case, those samples with analyte concentrations less than the reporting limit can be reported. All corrective actions must be documented on a Non-conformance memo. See policy WS-PQA-003 of the Quality Control Program for further details.

9.4. A Matrix Spike/Matrix Spike Duplicate (MS/MSD or MS/SD) pair must be prepared with every process batch of similar matrix, not to exceed twenty (20) samples. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside control limits must be within control limits in the LCS. Re-extraction of the blank, LCS, selected field samples, and the MS/MSD may be required after evaluation and review of the MS/MSD results.

Note: Samples identified as field blanks, equipment blanks, or trip blanks should not be used for sample/sample duplicate nor MS/MSD analysis.

9.5. A duplicate control sample (LCS/LCSD) may be substituted when insufficient volume is provided to process a sample/sample duplicate or MS/MSD pair if required by client or program.. The LCS and LCSD are evaluated independently for acceptance. See policy WS-PQA-003 of the Quality Control Program for further details.

10. CALIBRATION

10.1. A digestion vessel filled with reagent water is monitored for temperature for each digestion block. The analyst is to monitor this temperature for accuracy throughout the digestion and record the initial and final temperatures on the sample digestion log.

10.2. All air displacement pipettes must be calibrated over their range of use at least monthly. If the analyst suspects a spiking volume problem, calibration may be required more often. See SOP WS-QA-0004 for pipettor calibration verification procedures.

10.3. All volumetric digestion vessels must be calibrated according to the frequency and procedures outlined in SOP WS-QA-0004. If the analyst suspects a vessel's reliability, calibration may be required more often.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity,

chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. All preparation procedures must be carried out in a properly functioning hood.

11.3. All samples are to be checked out and back into sample control with the chain of custody documentation filled out completely. Samples are to be returned to the sample control area once all of the digestions have been initiated.

11.4. Proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be accurate and legible. Always set the samples up on the sample cart in the order with which they are to be dispensed. Double-check the sample bottle IDs, once prior to pouring them into the digestion vessels and before they are returned to the sample cart.

11.5. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/plant) are usually logged in with solid test codes. When initiating preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous but it appears more like a waste (biphasic, sludge-like, organic liquid, lots of sediment etc.) contact the lab supervisor or project manager for further instructions. In some cases it may be more appropriate to process these samples as solids.

11.6. Always read the QAS for every project prior to establishing batch associations. This is meant to assure that all client requirements are satisfied and it also aids in creating more efficient batches. Setting up batches to minimize QC and meet all client requirements is a skill that must be developed by all new personnel with the aid of skilled sample preparation and analytical staff.

11.7. Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards.

11.8. The following procedure must be followed for all aqueous sample preparations:

11.8.1. Use a small aliquot of each sample and measure the pH with pH indicator strips. If the bottles have an “X” on the tops, they have already been tested for other tests and do not require this step.

11.8.1.1. For samples with pH<2 put an "X" on top of the bottle indicating the samples were properly preserved. For these samples, record pH<2 on the preparation log.

11.8.1.2. For samples that test pH>2, notify the project manager immediately so they can contact the client. If the client requests the sample be preserved by the laboratory, add HNO_3 in 1.0 mL aliquots until the sample remains at pH<2 for at least 10 minutes. Let the sample stand for 24 hours and re-test the pH prior to preparation. As long as the pH<2, the sample can then be digested. A non-conformance memo must be created with an accounting of the anomalous event and the corrective action. Record "AF" for "Anomaly Filed" on the digestion log. Put an "X" on top of the bottle indicating the samples were properly preserved.

11.8.2. Mix the sample by shaking the container and pour the aliquot immediately. Shake the container between pouring the sample, MS, and SD.

11.8.3. Measure and transfer 50 mL of each sample into a graduated disposable digestion tube.

11.8.4. Measure two extra aliquots of the sample selected for the MS/MSD analysis.

11.8.5. Measure and transfer 50 mL of reagent water into digestion tubes for the method blank, LCS and LCSD (if required).

11.8.6. Using an adjustable volumetric air displacement pipette spike the LCS, LCSD, and MS/SD with the appropriate spiking solution/s shown in Tables I and II. ICP spikes require 0.5 mL of spiking solution and ICPMS spikes are spiked with 100 µL of spiking solution. A chemist trained in metals preparation and/or analysis must always witness the spiking procedure.

11.9. Proceed to the appropriate section for the desired method as follows:

Method 3005A	11.10
Method 3010A	11.11

11.10. Method 3005A - preparation for total recoverable or dissolved metals analysis by ICP or ICPMS (see Figure 1).

11.10.1. To each digestion tube, add 1 mL of concentrated HNO_3.

11.10.2. For ICP (method 6010B) digests, add 2.5 mL of concentrated HCl. For ICPMS (method 6020) digests, add 0.5 mL of concentrated HCl.

11.10.3. Heat at 90 - 95°C on a block digester until the volume is reduced to between

15 and 20 mL. Monitor the temperature regularly to assure proper heating.

Note: Do not allow samples to boil or go dry. Doing so will result in the loss of analytes and the samples must be re-prepared.

11.10.4. Cool the digestion tubes in a fume hood.

11.10.5. Adjust the final volume to 50 mL with reagent water. The sample is now ready for analysis

11.10.6. If insoluble material is present in the digestates, filter through Whatman 41 filter paper.

Note: If any samples in a preparation batch are filtered, the method blank and LCS associated with that batch must also be filtered.

Warning: Filtering, rinsing, and adjusting the volume of samples (when necessary) creates a significant risk of ergonomic injuries due to repetition and use of excessive force. Analysts performing these tasks must ensure that they do not perform any single task like this for more than 30 minutes without taking an ergonomic break or working on a different task. Analysts with smaller hands should ensure that they use 500 mL squirt bottles rather than 1 liter bottles, or use varying techniques (other than squirt bottles) for rinsing and volume adjustment when there are numerous samples to be processed.

Warning: The use of vacuum systems during filtration presents the risk of imploding glassware. All glassware used during vacuum operations must be thoroughly inspected prior to each use. Glass that is chipped, scratched, cracked, rubbed or marred in any manner must not be used under vacuum. It must be removed from service and replaced.

11.11. Method 3010A - preparation for total metals analysis by ICP (See Figure 2).

11.11.1. To the sample digestion tubes, add 1.5 mL of concentrated $HNO_{3.}$

11.11.2. Heat at approximately 95°C on block digesters until volume is reduced to between 15-20 mL. Monitor the temperature regularly to assure proper heating.

Note: Do not allow samples to boil or go dry. Doing so will result in the loss of analytes and the samples must be re-prepared.

11.11.3. Cool the digestion tubes in a fume hood to ambient temperature.

11.11.4. Add another1.5 mL portion of concentrated HNO_3.

11.11.5. Continue heating on the block digester for 20-25 minutes while ensuring that no portion of the bottom of the digestion tubes are allowed to go dry.

Note: If any sample shows a significant release of brown fumes while heating, add one more 1.5 mL aliquot of concentrated HNO_3 and heat for approximately 10 minutes.

11.11.6. Cool the digestion tubes in a fume hood to ambient temperature.

11.11.7. Add 2.5 mL of concentrated HCl.

11.11.8. Heat for an additional 15 minutes to dissolve precipitate or residue.

11.11.9. Cool the digestion tubes in a fume hood.

11.11.10. Adjust final volume to 50 mL with reagent water. The sample is now ready for analysis.

11.11.11. If insoluble material is present in the digestates, filter through Whatman 41 filter paper.

Note: If any samples in a preparation batch are filtered, the method blank and LCS associated with that batch must also be filtered.

Warning: Filtering, rinsing, and adjusting the volume of samples (when necessary) creates a significant risk of ergonomic injuries due to repetition and use of excessive force. Analysts performing these tasks must ensure that they do not perform any single task like this for more than 30 minutes without taking an ergonomic break or working on a different task. Analysts with smaller hands should ensure that they use 500 mL squirt bottles rather than 1 liter bottles, or use varying techniques (other than squirt bottles) for rinsing and volume adjustment when there are numerous samples to be processed.

Warning: The use of vacuum systems during filtration presents the risk of imploding glassware. All glassware used during vacuum operations must be thoroughly inspected prior to each use. Glass that is chipped, scratched, cracked, rubbed or marred in any manner must not be used under vacuum. It must be removed from service and replaced.

12. CALCULATIONS/DATA REDUCTION

Not Applicable.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest.

The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Acidic waste generated by the extraction and unused acidic digestate containing nitric and hydrochloric acid. This acidic liquid is consolidated into a plastic acid waste drum. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.2. Contaminated disposable materials such as plastic vials, pipettes, and filters used during sample preparation and digestion. Dump the solid waste into a contaminated lab trash bucket. When the bucket is full or after no more than one year, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update I, Revision 1, July 1992. Methods 3005A, 3010A.

16.2. Methods for the Chemical Analysis of Water and Waste (MCAWW), 1983, 1994. Methods 200.7, Revision 4.4, 1994; 200.8, Revision 5.4, 1994.

16.3. WS-MT-0003, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis of Water and Wastes, Method 6010B and Method 200.7.

16.4. WS-MT-0001, Analysis of Metals by Inductively coupled Plasma/Mass Spectrometry.

17. METHOD MODIFICATIONS

17.1. Modifications applicable to SW-846 reference methods.

17.1.1. The totals sample volume has been reduced from 100 mL to 50 mL to accommodate hot block digestion.

17.2. Modifications Specific to Method 3005A

17.2.1. Method 3005A is being used for the preparation of “total recoverable” metals in drinking waters.

17.2.2. The amount of HCl added is reduced to 0.5 mL for ICPMS digests.

17.3. Modifications Specific to Method 3010A

17.3.1. Section 11.12.2 of this SOP requires the sample be reduced to a volume of 15 – 20 mL. Section 7.2 of Method 3010A states the volume should be reduced to 3 mL but also states that no portion of the bottom of the digestion tube should go dry. The SOP required volume is a closer approximation of the volume required to provide an adequate covering of the digestion tube so as to prevent the loss of critical analytes through volatilization.

17.3.2. The scope of 3010A has been expanded to include silver based on comparison

studies with 7760A. Method 3010A consistently demonstrated improved accuracy and precision over Method 7760A in the matrices tested (reagent water, surface water and TCLP leachate) up to a concentration of 1 ppm silver.

17.4. Modifications Specific to MCAWW Methods

17.4.1. It was determined by technical review that several of the MCAWW methods were equivalent to the SW-846 methods and therefore were combined under the scope of this SOP as described in Section 11.0. The nature of these differences were deemed insignificant in regards to the amount of acid added and the evaporative volume based on the flexibility allowed by the methods (i.e., add additional acid as required) and the subjective wording of the methods (i.e., evaporate to near dryness vs. an exact volume).

18. ATTACHMENTS

18.1. Figure 1 — Method 3005A Flow Diagram

18.2. Figure 2 — Method 3010A Flow Diagram

18.3. Table 1 — Analyte List Certified Under NELAC Criteria: Method 6010B

18.4. Table 2 — Analyte List Certified Under NELAC Criteria: Method 6020

18.5. Appendix A — Contamination Control Guidelines

19. REVISION HISTORY

19.1. WS-IP-0001, Revision 5.2, Effective 10/31/2012

19.1.1. Removed all references to Methods 200.7 and 200.8 from SOP.

19.1.2. Editorial changes.

19.2. WS-IP-0001, Revision 5.1, Effective 10/02/2009

19.2.1. Changed Section 11.8.6 "… ICPMS spikes are spiked with 1.0 mL…" to "…ICPMS spikes are spiked with 100 µL".

19.2.2. Changed "Table 2 - Analyte List Certified Under NELAC Criteria, Method 6020" Source from Spex XCAL-45 to Spec XCAL-58 and each of the Initial Concentrations except Hg are increased by a factor of 10x.

19.3. WS-IP-0001, Revision 5, Effective 09/15/2008

19.3.1. Updated to TestAmerica format.

Figure 1
Method 3005A

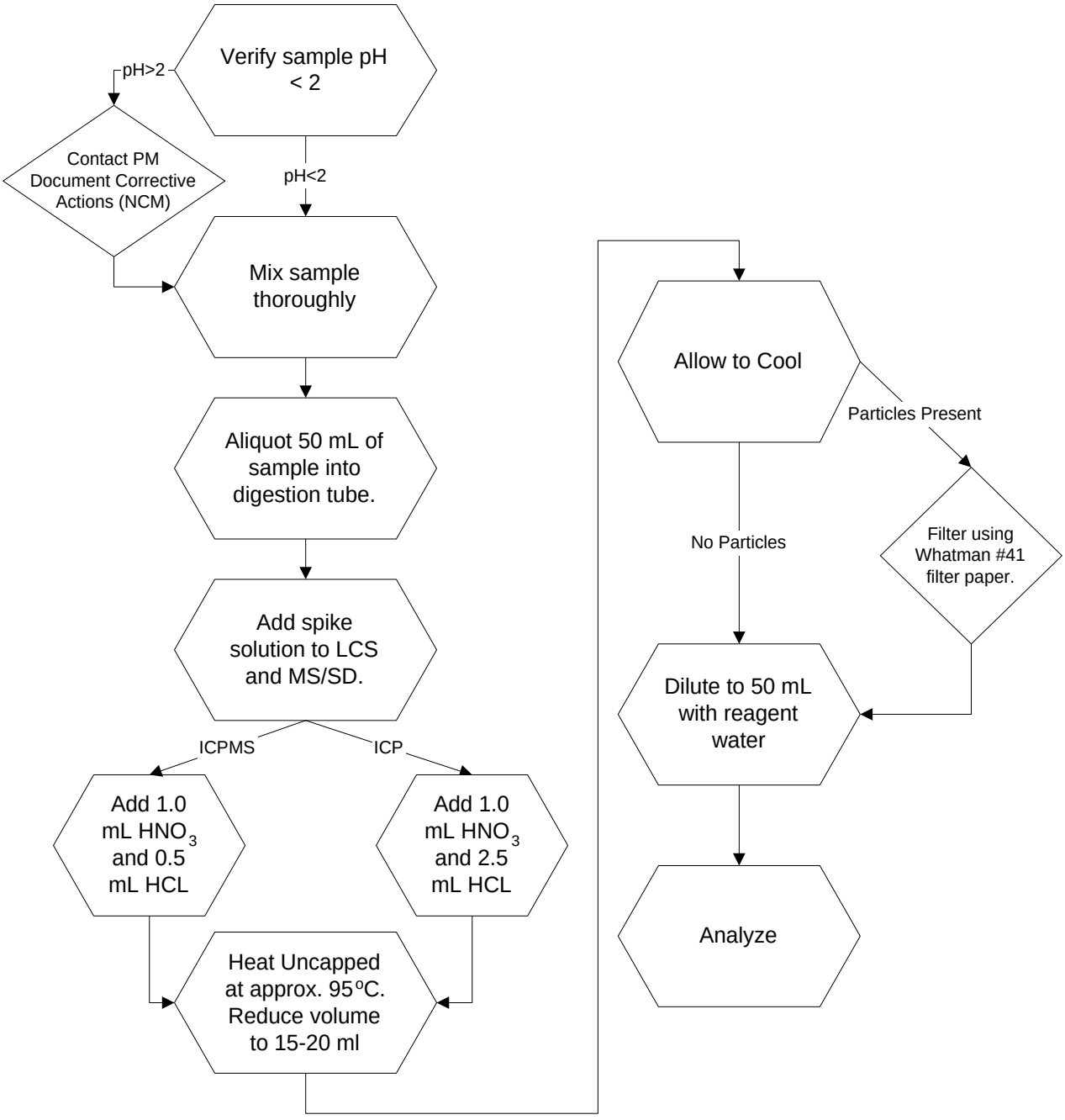

Figure 2

Method 3010A

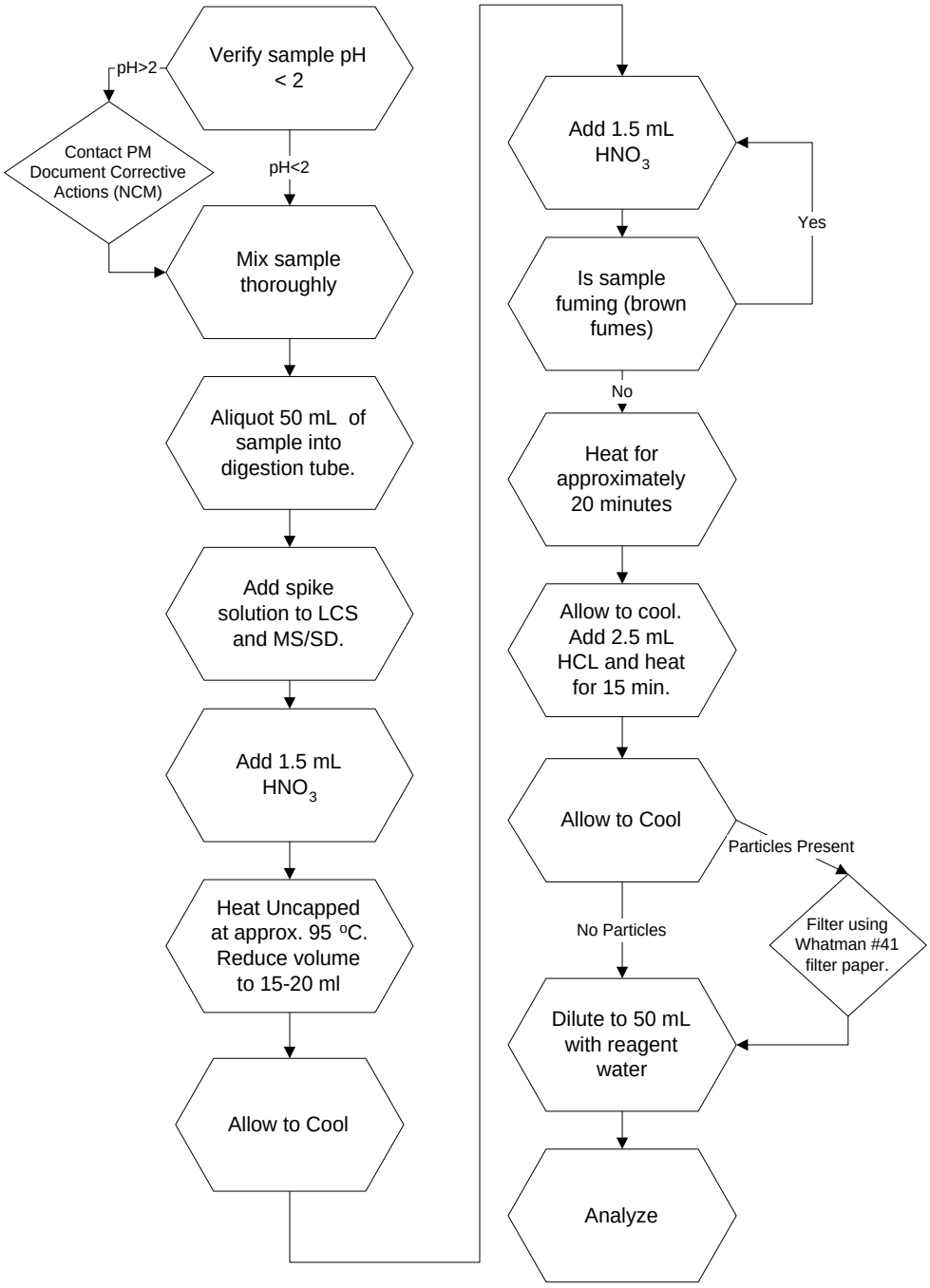

TABLE 1. Analyte List Certified Under NELAC Criteria: Method 6010B

Element	Symbol	Initial Conc mg/L	Final Conc mg/L	Source
Aluminum	Al	200	2.0	Spex XCAL-36
Antimony	Sb	50	0.5	Spex XCAL-36
Arsenic	As	200	2.0	Spex XCAL-36
Barium	Ba	200	2.0	Spex XCAL-36
Beryllium	Be	5.0	0.05	Spex XCAL-36
Boron	B	100	1.0	Spex XCAL-38
Cadmium	Cd	5.0	0.05	Spex XCAL-36
Calcium	Ca	5000	50	Spex XCAL-36
Chromium	Cr	20	0.2	Spex XCAL-36
Cobalt	Co	50	0.5	Spex XCAL-36
Copper	Cu	25	0.25	Spex XCAL-36
Iron	Fe	100	1.0	Spex XCAL-36
Lead	Pb	50	0.5	Spex XCAL-36
Lithium	Li	100	1.0	Spex XCAL-38
Magnesium	Mg	5000	50	Spex XCAL-36
Manganese	Mn	50	0.5	Spex XCAL-36
Molybdenum	Mo	100	1.0	Spex XCAL-36
Nickel	Ni	50	0.5	Spex XCAL-36
Phosphorous	P	1000	10	Spex XCAL-38
Potassium	K	5000	50	Spex XCAL-38
Selenium	Se	200	2.0	Spex XCAL-36
Silicon	Si	1000	10	Individual
Silver	Ag	5	0.05	Spex XCAL-36
Sodium	Na	5000	50	Spex XCAL-38
Strontium	Sr	100	1.0	Spex XCAL-38
Sulfur	S	1000	10	Spex XCAL-38
Thallium	Tl	200	2.0	Spex XCAL-36
Tin	Sn	200	2.0	Spex XCAL-36
Titanium	Ti	100	1.0	Spex XCAL-36
Vanadium	V	50	0.5	Spex XCAL-36
Zinc	Zn	50	0.5	Spex XCAL-36

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

TABLE 2 — Analyte List Certified Under NELAC Criteria: Method 6020

Element		Symbol		Source
		Initial Conc mg/L	Final Conc mg/L	
Aluminum	Al	500	1.0	Spex XCAL-58
Antimony	Sb	25	0.05	Spex XCAL-58
Arsenic	As	100	0.2	Spex XCAL-58
Barium	Ba	100	0.2	Spex XCAL-58
Beryllium	Be	100	0.2	Spex XCAL-58
Boron	B	500	1.0	Spex XCAL-58
Cadmium	Cd	100	0.2	Spex XCAL-58
Calcium	Ca	500	1.0	Spex XCAL-58
Chromium	Cr	100	0.2	Spex XCAL-58
Cobalt	Co	100	0.2	Spex XCAL-58
Copper	Cu	100	0.2	Spex XCAL-58
Iron	Fe	500	1.0	Spex XCAL-58
Lead	Pb	100	0.2	Spex XCAL-58
Lithium	Li	100	0.2	Spex XCAL-58
Magnesium	Mg	500	1.0	Spex XCAL-58
Manganese	Mn	100	0.2	Spex XCAL-58
Mercury	Hg	1.0	0.005	Individual
Molybdenum	Mo	100	0.2	Spex XCAL-58
Nickel	Ni	100	0.2	Spex XCAL-58
Phosphorous	P	500	1.0	Spex XCAL-58
Potassium	K	500	1.0	Spex XCAL-58
Selenium	Se	100	0.2	Spex XCAL-58
Silver	Ag	25	0 .05	Spex XCAL-58
Sodium	Na	500	1.0	Spex XCAL-58
Strontium	Sr	100	0.2	Spex XCAL-58
Thallium	Tl	25	0.05	Spex XCAL-58
Tin	Sn	100	0.2	Spex XCAL-58
Titanium	Ti	100	0.2	Spex XCAL-58
Uranium	U	100	0.2	Spex XCAL-58
Vanadium	V	100	0.2	Spex XCAL-58
Zinc	Zn	100	0.2	Spex XCAL-58

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

APPENDIX A. CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water. Disposable labware should be used whenever possible.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or Latex Gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

Title: Acid Digestion of Soils, SW-846 Method 3050B [Method EPA 3050B]

Approvals (Signature/Date):

David Allameh Technical Manager	Date: 1/16/12
Joe Schairer Health & Safety Manager / Coordinator	Date: 1/16/2012
Douglas Weir Quality Assurance Manager	Date: 01/24/12
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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation of soils, sediments, wastes, and other miscellaneous solid samples for the analysis of metals by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) and Inductively Coupled Plasma Atomic Emission Mass Spectroscopy (ICP/MS) as specified in SW846 Method 3050B.

1.2. Samples prepared by the protocols detailed in this SOP may be analyzed by ICP or ICP/MS for the elements listed in Tables I and II. Other elements and matrices may be analyzed following digestion by these protocols provided that the method performance criteria specified in Section 13.0 of this SOP are met.

1.3. This method is not a total digestion, but will dissolve most all metals that could become "environmentally available". By design, metals bound in silicate structures are not dissolved by this procedure, as they are not usually mobile in the environment

2. SUMMARY OF METHOD

A representative 1 g to 2 g (wet weight) portion of sample is digested in nitric acid, hydrogen peroxide, and hydrochloric acid. The extractions are then filtered and diluted to 100 mL.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include: metallic or metal-containing lab ware (e.g., talc gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2. The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Appendix A for additional contamination control guidelines.

4.3. Boron from borosilicate glassware will leach into the sample solution during and following sample processing. For critical low level determinations of boron only quartz and/or plastic lab ware should be used.

4.4. Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents and other matrices may not be digested using these methods if they are not soluble with acids. If physical interferences are present, they should be documented.

4.5. Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.6. Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs, the sample must be re-prepared. Antimony is easily lost by volatilization from hydrochloric media.

4.7. Specific analytical interferences are discussed in each of the determinative methods.

4.8. Available silica is lost during the preparation and therefore silica is not analyzed in solid matrices.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Opening, closing, filtering, rinsing, and adjusting the volume of samples (when necessary) creates a significant risk of ergonomic injuries due to repetition and use of excessive force. Analysts performing these tasks must ensure that they do not perform any single task like this for more than 30 minutes without taking an ergonomic stretch break, or working on a different task. Analysts with smaller hands should ensure that they use 500 mL squirt bottles rather than 1 liter bottles, or use varying techniques (other than squirt bottles) for rinsing and volume adjustments when there are numerous samples to be processed. There are numerous wrenches and tools available to reduce the impact of opening large numbers of sample containers or digestion tubes.

5.1.2. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.1.3. The acidification of samples containing reactive materials may result in the release of toxic gasses, such as cyanides or sulfides. Acidification of samples

must be done in a fume hood.

5.1.4. When digesting samples on a hot plate or digestion block, heat protective gloves and/or hot tongs must be used when handling containers. Ensure that digestion containers are arranged safely and are not overcrowded.

5.1.5. Acid washing of glassware is classified as a high-risk activity. A face shield must be worn over safety glasses or over safety goggles during this process.

5.1.6. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Vinyl and nitrile gloves all provide satisfactory protection against the reagents used in this process. However, if any organic solvents are used, or any sample matrix contains organic solvents, only nitrile gloves should be used.

5.1.7. Exposure to chemicals must be maintained as low as reasonably achievable; therefore all samples must be opened, transferred, prepared, digested and cooled in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.8. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrogen Peroxide	Oxidizer Corrosive	1 ppm-TWA	Vapors are corrosive and very irritating to the respiratory tract, eyes and skin.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Hot block digestion unit capable of maintaining a temperature of 90-95°C.

6.2. Digestion tubes: graduated volume relative to type of hot block.

6.3. Thermometer that covers a temperature range of 0-200°C.

6.4. Whatman No. 41 filter paper.

6.5. Wooden tongue depressors or stainless steel spatulas.

6.6. Top-loading balance capable of accurately weighing to the nearest 0.01 g.

6.7. Bottle-top dispensers.

6.8. Calibrated adjustable air displacement pipettes.

6.9. 4 oz graduated snap cap containers for final transfer of digestions.

6.10. Teflon® boiling chips.

7. REAGENTS AND STANDARDS

7.1. Use reagent grade chemicals in all tests. "Certificates of Analysis" should be supplied with all chemicals purchased. If not supplied, contact the vendor. When received, label the certificate and the reagent container with the receipt date. Reagent containers also need to be labeled with the opened and expiration dates.

7.2. Reagent water is produced by a Millipore nanopure system. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.3. Laboratory Control Sample (LCS) and matrix spike (MS) solutions are purchased as certified custom TestAmerica solutions (Tables I, II). All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem. All stock standards must be labeled with the date of receipt and the date the standard is opened.

7.4. The LCS and MS samples must contain all the elements designated for analysis. If a non-routine element is required that is not contained in the custom TestAmerica solution, the lab must purchase a solution from a designated vendor that will cover the additional analyte(s) of interest and provide for a final spike concentration that is appropriate to the determinative method.

7.5. Nitric acid (HNO_3), concentrated, trace metal grade or better.

7.6. Hydrochloric acid (HCl), concentrated, trace metal grade or better.

7.7. 1:1 Hydrocloric acid: add 500 mL of concentrated HCl to 500 mL of reagent water.

7.8. 30% Hydrogen peroxide (H_2O_2), reagent grade.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2. Soil samples do not require preservation but must be stored at 4 °C ± 2 °C until the time of analysis.

9. QUALITY CONTROL

9.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A

batch must be prepared within the same time frame. A method blank (MB) and a laboratory control sample (LCS) or duplicate control sample (LCS/LCSD) must be prepared as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/SD), or in some instances a sample/sample duplicate. An analysis batch must include all QC samples, however they do not contribute to the maximum of 20 samples. See policy WS-PQA-003 of the Quality Control Program for more details.

9.2. One method blank (MB) must be prepared for every 20 samples. A method blank consists of boiling chips processed through all of the steps, and at the same time as the associated samples. If a method blank exceeds +/- the reporting limit for a given analyte than the samples associated with that batch must be re-prepared. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo. For DOD projects, the MB criteria is less than ½ the reporting limit. See policy WS-PQA-003 of the Quality Control Program for further details.

9.3. A laboratory control sample (LCS) must be prepared for every 20 samples. A LCS consists of boiling chips spiked with the analytes of interest and processed through all of the steps, and at the same time as the associated samples. If a LCS is outside of percent recovery acceptance criteria, all of the samples associated with that LCS must be re-prepared except when a LCS exhibits high recovery. For such a case, those samples with analyte concentrations less than the reporting limit can be reported. All corrective actions must be documented on a Non-conformance memo. See policy WS-PQA-003 of the Quality Control Program for further details.

9.4. A Matrix Spike/Matrix Spike Duplicate (MS/MSD) pair must be prepared with every process batch of similar matrix, not to exceed twenty (20) samples. MS/MSD pairs are aliquots of a selected field sample spiked with all of the analytes of interest at known concentrations. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside control limits must be within control limits in the LCS. Re-extraction of the blank, LCS, selected field samples, and the MS/MSD may be required after evaluation and review of the MS/MSD results.

9.5. A duplicate control sample (LCS/LCSD) may be substituted when insufficient volume is provided to process a MS/MSD pair as required by client or regulatory requirements. The LCS and LCSD are evaluated independently for acceptance. See policy WS-PQA-003 of the Quality Control Program for further details

9.6. Quality Assurance Summaries: certain clients may require specific project or program QA information that supersedes the SOP requirements. Quality Assurance Summaries (QAS) should be developed by the PM's to address these requirements. Sample preparation analysts are required to read and print each QAS for every project they

prepare. These are transferred to the instrument analysts with the sample digestions.

10. CALIBRATION

10.1. A digestion vessel filled with reagent water is monitored for temperature for each digestion block. The analyst is to monitor this temperature for accuracy throughout the digestion and record the initial and final temperatures on the sample digestion log.

10.2. All air displacement pipettes must be calibrated over their range of use at least monthly. If the analyst suspects a spiking volume problem, calibration may be required more often. See SOP WS-QA-0004 for pipettor calibration verification procedures.

10.3. All volumetric digestion vessels must be calibrated according to the frequency and procedures outlined in SOP WS-QA-0004. If the analyst suspects a vessel's reliability, calibration may be required more often.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. All preparation procedures must be carried out in a properly functioning hood.

11.3. All samples are to be checked out and back into sample control with the chain of custody documentation filled out completely. Samples are to be returned to the sample control area once all of the digestions have been initiated.

11.4. Proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be accurate and legible. Always set the samples up on the sample cart in the order with which they are to be dispensed. Double-check the sample bottle IDs, once prior to aliquotting them into the digestion vessels and before they are returned to the sample cart.

11.5. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludge and tissues (animal/plant) are usually logged in with solid test codes. When initiating preparation, examine the sample to see if the sample matches the

matrix designation. If the sample is logged in as solid but it appears more like a liquid, contact the department manager or project manager for further instructions.

11.6. Always read the QAS for every project prior to establishing batch associations. This is meant to assure that all client requirements are satisfied and it also aids in creating more efficient batches. Setting up batches to minimize QC and meet all client requirements is a skill that must be developed by all new personnel with the aid of skilled sample preparation and analytical staff.

11.7. Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards.

11.8. Preparation of Soils, Sediments and Sludges for Analysis by ICP and ICP/MS.

11.8.1. SOP WS-QA-0018 must be followed to properly homogenize and aliquot solid samples.

11.8.2. Weigh out a 1.00 – 2.00 g sample aliquot into a graduated hot block tube using a wooden tongue depressor.

11.8.2.1. A 1.00 g +/- 5% aliquot is normal for samples that show no apparent free liquid phase or glistening from an aqueous phase.

11.8.2.2. A 1.4 g – 1.5 g aliquot should be used for samples with a muddy, glistening texture or small amount of free liquid.

11.8.2.3. A 2.0 g +/- 5% aliquot should be used for samples with a notable free liquid phase that does not mix into a structured muddy texture.

11.8.3. When sub-sampling for the MS/MSD sample aliquots, first transfer the sample per section 11.9.1 into a 50 mL polystyrene beaker and mix thoroughly before weighing the three replicates into the graduated hot block tubes.

WARNING: Opening, closing, filtering, rinsing, and adjusting the volume of samples (when necessary) creates a significant risk of ergonomic injuries due to repetition and use of excessive force. Analysts performing these tasks must ensure that they do not perform any single task like this for more than 30 minutes without taking an ergonomic stretch break, or working on a different task. Analysts with smaller hands should ensure that they use 500 mL squirt bottles rather than 1 liter bottles, or use varying techniques (other than squirt bottles) for rinsing and volume adjustments when there are numerous samples to be processed. There are numerous wrenches and tools available to reduce the impact of opening large numbers of sample containers or digestion tubes.

11.8.4. Weigh out approximately 1.00g of Teflon® boiling chips into digestion tubes for MB and LCS/LCSD. For ICPMS, spike 0.2 mL of spiking solution into

the LCS/MS/MSD. For ICP, use 1.0 mL of spiking solution. Tables I and II show the appropriate solutions to use and their concentrations. The final spiking levels are also listed.

11.8.5. Add 5.0 mL of reagent water to all of the digestion vessels.

11.8.6. Add 5.0 mL of concentrated HNO_3 and heat the samples to 90-92ºC and reflux for 10 minutes without boiling. For ICPMS only, add 5.0 mL of 1:1 HCl prior to heating.

11.8.7. Heat the samples to 90-92ºC and reflux for 10 minutes without boiling. Allow the samples to cool.

Note: Do not allow samples to boil or go dry during any part of the digestion. Doing so will result in the loss of analyte and the sample must be re-prepared.

11.8.8. Add 5.0 mL of concentrated HNO_3 for both ICP and ICPMS.

11.8.9. Reflux at 90-92°C for 30 minutes. Add reagent water as needed to ensure that the volume of solution is not reduced to less than 5 mL.

11.8.10. If brown fumes are observed, add concentrated HNO_3 in 5.0 mL aliquot with 30 minute refluxing cycles at 90-92º until no more fumes are observed.

11.8.11. Allow the sample to evaporate to approximately 5 mL while ensuring that no portion of the bottom of the tube is allowed to go dry. Do not heat the samples for more than 2 hrs. Allow the samples to cool.

11.8.12. Add 2 mL of reagent water and 3 mL of 30 % H_2O_2. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence.

Note: If the samples are very dark or look organic in nature, add the 30% H_2O_2 in 1.0 mL aliquots with short heating cycles to assure sample is not lost due to excessive effervescence.

11.8.13. Heat the samples for 15 minutes. Allow the samples to cool.

11.8.14. Add 3.0 mL H_2O_2 and continue heating at 90-92ºC until the volume is reduced to approximately 5 mL. Do not exceed 2.0 hrs.

11.8.15. If the samples are being prepared for ICP analyses, add 5.0 mL of concentrated HCl and reflux for an additional 15 minutes without boiling.

11.8.16. If the samples are being prepared for ICPMS, add 5.0 mL of 1:1 HCl and reflux for an additional 15 minutes without boiling.

11.8.17. Allow the samples to cool and filter through Whitman #41 filter paper directly

into 4 oz graduated snap cap containers. Dilute to a final volume of 100 ml with reagent water.

11.9. Filtration procedure:

11.9.1. Carefully pour the contents of each of the hot block digestion tubes into folded filter paper on top of the 4 oz containers. Be careful not to lose any of the contents through splashing.

11.9.2. Allow the contents to flow through the filter paper. Rinse each of the hot block tubes twice through the filter paper with reagent water.

11.9.3. Using reagent water, rinse each of the filter papers three times allowing the contents to filter thoroughly between rinses.

11.9.4. Adjust the final volume of the digestates to 100 mL with reagent water.

12. CALCULATIONS/DATA REDUCTION

Not Applicable.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each

analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Acidic waste generated by the digestion and unused acidic digestate containing nitric and hydrochloric acid. This acidic liquid is consolidated into a plastic acidic waste drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.2. Contaminated disposable materials such as plastic vials, pipettes, and filters used during sample preparation and digestion. Dump the solid waste into a contaminated lab trash bucket. When the bucket is full, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, December 1996. Method 3050B.

16.2. WS-PQA-003: Quality Control Program

16.3. WS-QA-0004: Calibration of Autopippetors, Autodispensers, and Volumetric Containers

16.4. WS-QA-0018: Subsampling

17. METHOD MODIFICATIONS

17.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit.

17.2. Watch glasses are not used with the digestion blocks.

17.3. Samples are not centrifuged, but always filtered with Whatman #41 filter paper.

17.4. Samples are not sieved prior to weighing unless special instructions are given.

17.5. 5.0 mL of 1:1 HCl is added to the ICPMS digestions during the initial addition of reagents as studies have shown this increases the performance of silver analysis.

17.6. Temperature conditions of 95ºC ± 5ºC have been modified to 90-92ºC due to loss of silver at higher temperatures.

17.7. During the second step of H_2O_2 addition, 3.0 mL is added to all standards and samples instead of the steady additions of 1.0 mL aliquots.

17.8. For the final addition of HCl to the ICP aliquots, 5.0 mL of concentrated HCl is added instead of 10 mL.

17.9. 5.0 mL of 1:1 HCl is added to the final preparation phase for ICPMS to increase the performance of silver.

18. ATTACHMENTS

18.1. Figure 1 — Method 3050B (Modified) Flowchart

18.2. Table 1 — Analyte List Certified Under NELAC Criteria: Method 6010B

18.3. Table 2 — Analyte List Certified Under NELAC Criteria: Method 6020

18.4. Appendix 1 — Contamination Control Guidelines

19. REVISION HISTORY

19.1. WS-IP-0002, Revision 5.3, Effective 01/19/2012

19.1.1. Section 6.10: “Teflon boiling chips”.

19.1.2. Section 11.8.4: added “Weigh out approximately 1.00g of Teflon® boiling chips into digestion tubes for MB and LCS/LCSD.”

19.2. WS-IP-0002, Revision 5.2, Effective 12/17/2010

19.2.1. Section 11.8.4: Changed ICPMS spiking level from 2.0 mL to 0.2 mL.

19.2.2. Updated Table II Source and Initial Conc. Levels for all analytes.

19.3. WS-IP-0002, Revision 5.1, Effective 10/19/2009

19.3.1. Revise Section 11.8.4 to read, "For ICPMS, spike 2.0 mL of spiking solution into the LCS/MS/MSD. For ICP, use 1.0 mL of spiking solution. Tables I and II show the appropriate solutions to use and their concentrations. The final spiking levels are also listed."

19.3.2. Revise Section 11.8.5 to read, "Add 5.0 mL of reagent water to all of the digestion vessels."

19.3.3. Add Section 11.9.4 to read, "Adjust the final volume of the digestates to 100 mL with reagent water."

19.3.4. Revised the flow chart (Figure 1) to reflect the changes above.

19.4. WS-IP-0002, Revision 5, Effective 09/30/2008

19.4.1. Updated to current TestAmerica format.

19.4.2. Added HCl to last acid addition for ICPMS analysis.

19.4.3. Change volumes to approximately 5 mL from 5-10 mL for reduction steps.

19.5. WS-IP-0002, Rev. 4, Effective 9/11/07

19.5.1. The SOP format was updated to TestAmerica format.

19.5.2. Reference to Silica was removed.

Figure 1: Method 3050B (modified) Flowchart

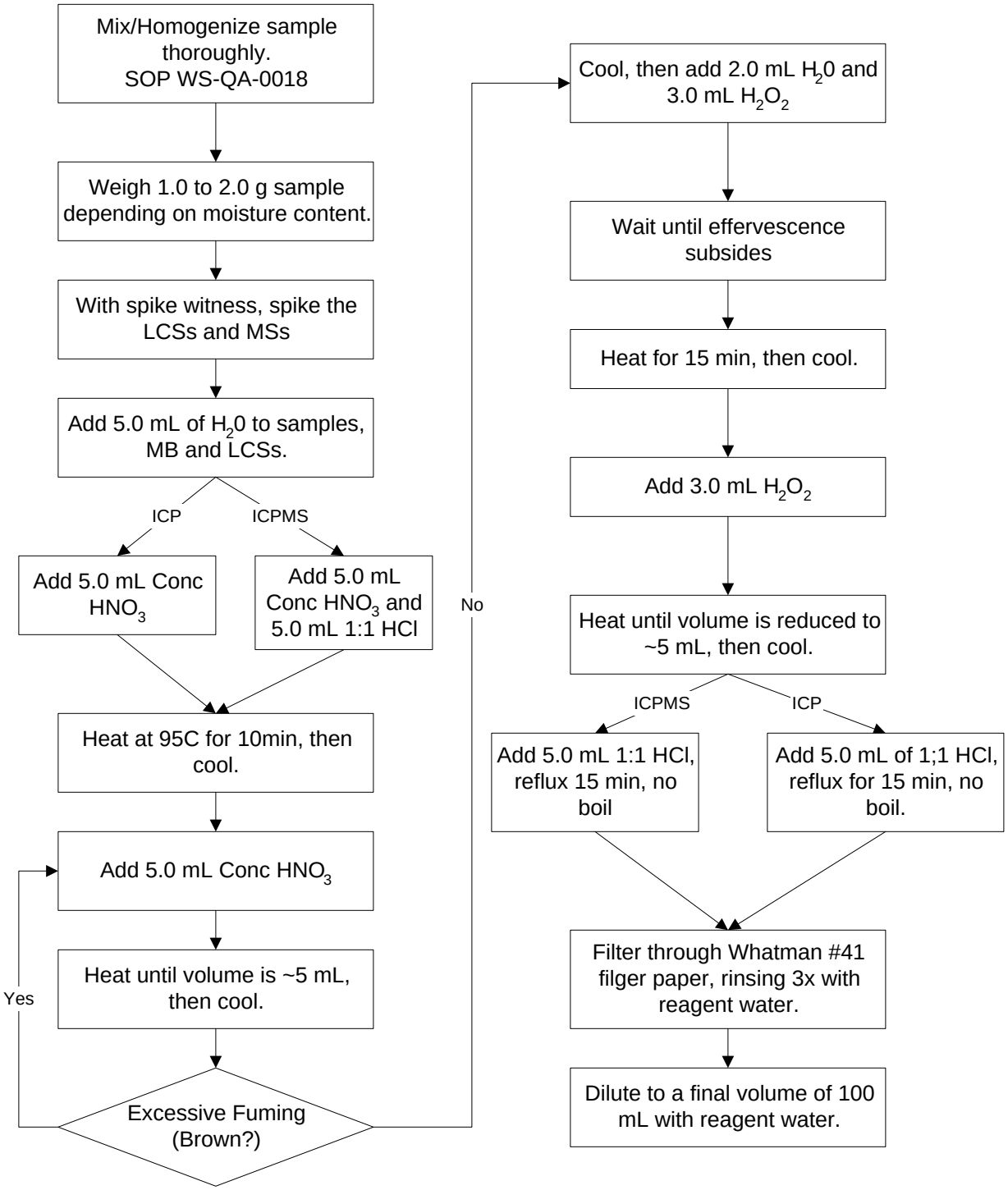

TABLE I
Analyte List Certified Under NELAC Criteria: Method 6010B

Element		LCS/MS/SD Spiking		Source
		Initial Conc. mg/L	Final Conc. mg/Kg	
Aluminum	Al	200	200	Spex XCAL-36
Antimony	Sb	50	50	Spex XCAL-36
Arsenic	As	200	200	Spex XCAL-36
Barium	Ba	200	200	Spex XCAL-36
Beryllium	Be	5.0	5.0	Spex XCAL-36
Boron	B	100	100	Spex XCAL-38
Cadmium	Cd	5.0	5.0	Spex XCAL-36
Calcium	Ca	5000	5000	Spex XCAL-36
Chromium	Cr	20	20	Spex XCAL-36
Cobalt	Co	50	50	Spex XCAL-36
Copper	Cu	25	25	Spex XCAL-36
Iron	Fe	100	100	Spex XCAL-36
Lead	Pb	50	50	Spex XCAL-36
Lithium	Li	100	100	Spex XCAL-38
Magnesium	Mg	5000	5000	Spex XCAL-36
Manganese	Mn	50	50	Spex XCAL-36
Molybdenum	Mo	100	100	Spex XCAL-36
Nickel	Ni	50	50	Spex XCAL-36
Phosphorous	P	1000	1000	Spex XCAL-38
Potassium	K	5000	5000	Spex XCAL-38
Selenium	Se	200	200	Spex XCAL-36
Silver	Ag	5	5	Spex XCAL-36
Sodium	Na	5000	5000	Spex XCAL-38
Strontium	Sr	100	100	Spex XCAL-38
Sulfur	S	1000	1000	Spex XCAL-38
Thallium	Tl	200	200	Spex XCAL-36
Tin	Sn	200	200	Spex XCAL-36
Titanium	Ti	100	100	Spex XCAL-36
Vanadium	V	50	50	Spex XCAL-36
Zinc	Zn	50	50	Spex XCAL-36

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

TABLE II
Analyte List Certified Under NELAC Criteria: Method 6020

Element		Symbol		Source
		Initial Conc. mg/L	Final Conc. mg/L	
Aluminum	Al	500	1.0	TACA-1
Antimony	Sb	100	0.05	TACA-2
Arsenic	As	100	0.2	TACA-1
Barium	Ba	100	0.2	TACA-1
Beryllium	Be	100	0.2	TACA-1
Boron	B	100	1.0	TACA-1
Cadmium	Cd	100	0.2	TACA-1
Calcium	Ca	500	1.0	TACA-1
Chromium	Cr	100	0.2	TACA-1
Cobalt	Co	100	0.2	TACA-1
Copper	Cu	100	0.2	TACA-1
Iron	Fe	500	1.0	TACA-1
Lead	Pb	100	0.2	TACA-1
Lithium	Li	100	0.2	TACA-1
Magnesium	Mg	500	1.0	TACA-1
Manganese	Mn	100	0.2	TACA-1
Molybdenum	Mo	100	0.2	TACA-2
Nickel	Ni	100	0.2	TACA-1
Phosphorous	P	500	1.0	TACA-1
Potassium	K	500	1.0	TACA-1
Selenium	Se	100	0.2	TACA-1
Silver	Ag	25	0 .05	TACA-1
Sodium	Na	500	1.0	TACA-1
Strontium	Sr	100	0.2	TACA-1
Thallium	Tl	25	0.05	TACA-1
Tin	Sn	100	0.2	TACA-2
Titanium	Ti	100	0.2	TACA-2
Uranium	U	100	0.2	TACA-1
Vanadium	V	100	0.2	TACA-1
Zinc	Zn	100	0.2	TACA-1

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

Appendix I

CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

- All work areas used to prepare standards and spikes should be cleaned before and after each use.
- All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.
- Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.
- Auto sampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

Title: GC/MS Analysis Based on Method 8270C [Method 8270C]

Approvals (Signature/Date):

David Allameh Technical Manager	6/22/10 Date
Joe Schairer Health & Safety Manager / Coordinator	7/7/2010 Date
Douglas Weir Quality Assurance Manager	08/06/10 Date
Karla Buechler Laboratory Director	8/9/10 Date

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1. SCOPE AND APPLICATION

1.1. This method is based upon methods SW846 8270C and TO-13A, and is applicable to the determination of the concentration of semivolatile organic compounds in extracts prepared from solid, aqueous, and air matrices. Direct injection of a sample may be used in limited applications. Refer to Table 1 for the list of compounds applicable for this method. Additional compounds may be amenable to this method. Refer to Section 4 for problematic analytes. If non-standard analytes are required, they must be validated by the procedures described in Section 13 before sample analysis.

1.2. The standard reporting limit (SRL) of this method for determining an individual compound is approximately 0.33 mg/kg (wet weight) for soil/sediment samples, 1 - 200 mg/kg for wastes (dependent on matrix and method of preparation), and 10 µg/L for groundwater samples. Some compounds have higher reporting limits. Refer to Table 1 for specific SRLs. Reporting limits will be proportionately higher for sample extracts that require dilution.

1.3. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPP Implementation" must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Aqueous samples are extracted with methylene chloride using a separatory funnel, or a continuous extractor. Solid samples are extracted with methylene chloride/acetone using either sonication, or Soxhlet extraction. Waste dilution is used for samples that are miscible with the solvent. Air filter and absorbent cartridges are extracted by Soxhlet. The extract is dried, concentrated to a volume of 1 mL, and analyzed by GC/MS. Extraction procedures are detailed in WS-OP-0001 for aqueous, soil and waste, and in WS-OP-0006 for air matrices.

2.2. Qualitative identification of the parameters in the extract is performed using the retention time and the relative abundance of characteristic ions. Quantitative analysis is performed using the internal standard technique with a single characteristic ion.

3. DEFINITIONS

3.1. CCC (Calibration Check Compounds) - A subset of target compounds used to evaluate the calibration stability of the GC/MS system. A maximum percent deviation of the CCC's is specified for calibration acceptance.

3.2. SPCC (System Performance Check Compounds) - Target compounds designated to

monitor chromatographic performance, sensitivity, and compound instability or degradation on active sites. Minimum response factors are specified for acceptable performance.

3.3. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.4. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Raw GC/MS data from all blanks, samples, and spikes must be evaluated for interferences. If an interference is detected it is necessary to determine if the source of interference is in the preparation and/or cleanup of the samples; then take corrective action to eliminate the problem.

4.2. The use of high purity reagents, solvents, and gases helps to minimize interference problems.

4.3. Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the sample.

4.4. Phthalate contamination is commonly observed in this analysis and its occurrence should be carefully evaluated as an indicator of a contamination problem in the sample preparation step of the analysis.

4.5. The following compounds may require special treatment when being determined by this method:

4.5.1. Benzidine analytes can be subject to oxidative losses during solvent concentration and exhibits poor chromatography.

4.5.2. Hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reaction in acetone solution, and photochemical decomposition.

4.5.3. N-Nitrosodiphenylamine decomposes in the gas chromatographic inlet and cannot be distinguished from diphenylamine.

4.5.4. Pentachlorophenol, 2,4-dinitrophenol, 4-nitrophenol, 4,6-dinitro-2-methylphenol, 4-chloro-3-methylphenol, benzoic acid, 2-nitroaniline, 3-nitroaniline, 4-chloroaniline, and benzyl alcohol are subject to erratic chromatographic behavior, especially if the GC system is contaminated with high boiling material.

4.5.5. 3-Methylphenol cannot be separated from 4-methylphenol by the conditions specified in this method, and is reported as 4-methylphenol.

4.6. Hexachlorophene, kepone, famphur, and methapyrilene are unstable in methylene chloride and degrade soon after exposure to the solvent. Although these compounds can be detected in newly prepared standards and recently extracted samples, they cannot be detected in older calibration standards, and older standards are unable to meet calibration criteria for these four compounds.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, Sacramento Supplement to the EHSM, and this document. All work must be stopped in the event of a known or potential compromise to the health or safety of an associate. The situation must be reported immediately to a supervisor, the EH&S Staff, or a senior manager.

5.1. Specific Safety Concerns or Requirements

5.1.1. Ensure that all instrument exhaust vents and lines are properly connected to either a laboratory vent or an appropriate filter. Instruments may not be vented to the working environment.

5.1.2. The autovials used on the instrument contain a small amount of solvent after the analysis is completed, which can evaporate into the air through the puncture in the septa. These autovials may be collected in an open tripour or similar cup at the instrument while the analyst is removing them from the tray, but once that is complete the vials must be transferred to a waste container in a fume hood. They cannot be left out on the bench by the instrument.

5.1.3. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Nitrile gloves should be used when working with solvent or extract containers. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP, and should not be used.

5.1.4. Exposure to chemicals must be maintained **as low as reasonably achievable**. All preparation of standards and dilutions shall be performed inside an operating fume hood. All samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless

transfers are being made.

5.1.5. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Gas Chromatograph/Mass Spectrometer System: An analytical system complete with a temperature-programmable gas chromatograph suitable for split/splitless injection and all required accessories, including syringes, analytical columns, and gases. The capillary column should be directly coupled to the source.

6.2. Column: 30 m x 0.32 mm I.D. (or 0.25 mm I.D.) 0.25-µm film thickness silicon-coated fused-silica capillary column (J & W Scientific DB-5.625 or equivalent). Alternate columns are acceptable if they provide acceptable performance.

6.3. Mass Spectrometer: Capable of scanning from 35 to 500 AMU every one second or

less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer (HP5973) must be capable of producing a mass spectrum for decafluorotriphenylphosphine (DFTPP) which meets all of the criteria in Table 3 when 50 ng of the GC/MS tuning standard is injected through the GC.

6.4. GC/MS Interface: Any GC-to-MS interface that gives acceptable calibration points and achieves acceptable tuning performance criteria may be used (GC used is HP6890).

6.5. Data System: A computer system must be interfaced to the mass spectrometer. The system must allow the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that can search any GC/MS data file for ions of a specific mass and that can plot such ion abundances versus time or scan number. This type of plot is defined as the Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundances in any EICP between specified time or scan-number limits. The most recent version of the NIST Mass Spectral Library is recommended.

6.6. Syringe: 10 µL Hamilton Laboratory grade syringes or equivalent.

6.7. Carrier gas: Ultra high purity helium.

7. REAGENTS AND STANDARDS

7.1. A minimum five-point calibration curve is prepared. The low point should be at or below the reporting limit. Refer to Tables 9 and 10 for typical calibration levels for all analytes. Other calibration levels may be used, depending on instrument capability, but the low standard must support the reporting limit and the high standard defines the range of the calibration.

7.2. An Internal Standard solution is prepared in methylene chloride (DCM). Compounds in the I.S. Mix are: acenaphthene-d10, chrysene-d12, 1,4-dichlorobenzene-d4, naphthalene-d8, perylene-d12, and phenanthrene-d10. See Table 7 for composition of this solution. This solution is valid for up to one year.

7.2.1. Internal Standards are added to all standards and extracts to result in 40 ng injected onto the column. For example, if the volume of an extract used is 1000 µL, 20 µL of a 2000 µg/mL internal standard solution would be added for a 1 µL injection.

7.3. Surrogate Standard Spiking Solution: Prepare as indicated in the preparative methods. See appropriate preparation SOP. Surrogate compounds and levels are listed in Table 6.

7.4. GC/MS Tuning Standard: A methylene chloride solution containing 50 µg/mL o-decafluorotriphenylphosphine (DFTPP) is prepared. Pentachlorophenol, benzidine, and DDT, should also be included in the Tuning Standard at 50µg/mL. This solution is valid for one year.

7.5. Laboratory Control Spiking Solution: Prepare as indicated in the preparative methods. See appropriate preparation SOP. LCS compounds and levels are listed in Table 5.

7.6. Matrix Spike Solution: Prepare as indicated in the preparative methods. See preparation SOP. The matrix spike compounds and levels are the same as the LCS compounds.

7.7. The standards listed in 7.1 to 7.6 should be refrigerated at ≤ 6ºC when not in use. Refrigeration at -10ºC to -20ºC may be used if it can be demonstrated that analytes do not fall out of solution at this temperature. The continuing calibration standard is stored at ≤ 6ºC.

7.8. The daily instrument standard should be refreshed or reprepared on a weekly basis, to avoid concentration effects.

7.9. The standards must be replaced at least once a year. Rotate them to the Hazardous Waste storage area for disposal..

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Refer to SOP WS-OP-0001 and WS-OP-0006 for sample bottle preservation and storage.

8.2. Extracts are stored at –10 to -20°C until at least 30 days following invoicing.

8.3. Extracts must be analyzed within 40 days of extraction.

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability

9.1.1. For the standard analyte list, the initial demonstration and method detection limit (MDL) studies described in Section 13 must be acceptable before analysis of samples may begin.

9.1.2. For non-standard analytes an MDL study should be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial

demonstration required is analysis of an extracted standard at the reporting limit and a single point calibration.

9.2. Control Limits

In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). These limits must be determined at least annually. The recovery limits are mean recovery ±3 standard deviations for surrogates, MS and LCS. Precision limits for matrix spikes/matrix spike duplicates are mean relative percent difference ± 3 standard deviations.

9.2.1. These limits do not apply to dilutions (except for tests without a separate extraction), but surrogate and matrix spike recoveries will be reported unless the dilution is 5X or greater.

9.2.2. All surrogate, LCS, and MS recoveries (except for dilutions) must be entered into QuantIMS (when available) or other database so that accurate historical control limits can be generated. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.2.3. Refer to WS-PQA-003 for further details of control limits.

9.2.4. Current control limits for surrogates, LCS, and matrix spikes may be obtained by using QC Browser or an equivalent tool to query the LIMS database.

9.3. Method Blank

A method blank is prepared and analyzed with each batch of samples. The laboratory will attempt to run all samples from a preparation batch within the same sequence on the instrument. If this is not possible, samples may be run on different sequences or different instruments, if accompanied by an instrument blank as per Section 9.4. The method blank consists of reagent water for aqueous samples, and sodium sulfate for soil samples (Refer to SOP WS-OP-0001 and WS-OP-0006 for details). Surrogates are added and the method blank is carried through the entire analytical procedure. The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, see below) or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

- If the analyte is a common laboratory contaminant (phthalate esters), the data may be reported with qualifiers if the concentration of the analyte is less than five times the RL. Such action must be taken in consultation with the client.
- Reanalysis of any samples with reportable concentrations of analytes found in the method blank is required unless other actions are agreed with the client.
- If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.
- The method blank must have acceptable surrogate recoveries. If surrogate recoveries are not acceptable, the data must be evaluated to determine if the

method blank has served the purpose of demonstrating that the analysis is free of contamination. If surrogate recoveries are low, and there are reportable analytes in the associated samples, re-extraction of the blank and affected samples will normally be required. Consultation with the client should take place.

- The DOD QSM criteria for method blanks is no analytes detected greater than ½ the reporting limit (RL). For common laboratory contaminants, it is no analytes detected greater than the RL.

9.3.1. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all associated samples are flagged with a "B", and appropriate comments may be made in a narrative to provide further documentation.

9.3.2. Refer to WS-PQA-003 for further details of the corrective actions.

9.3.3. Sample results are NOT blank subtracted unless specific requests and arrangements have been made with a client or agency.

9.4. Instrument Blank

Instruments must be evaluated for contamination during each 12 hour analytical run. This may be accomplished by analysis of a method blank. If a method blank is not available, an instrument blank must be analyzed. An instrument blank consists of methylene chloride with the internal standards added. It is evaluated in the same way as the method blank.

9.5. Laboratory Control Sample (LCS)

A laboratory control sample (LCS) is prepared and analyzed with every batch of samples. All analytes must be within established control limits. The LCS contains a representative subset of the analytes of interest (see Table 5), and must contain the same analytes as the matrix spike. Upon client request, additional analytes may be added to the LCS. If any control analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch. The analyst should monitor the system if non-control analytes are outside of established control limits, and perform corrective action as necessary to prevent re-occurring failures.

- If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. (An example of acceptable reasons for not reanalyzing might be that sample was non-detect and the LCS had high recoveries, indicating a high bias).
- If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.

- If a sample is re-extracted past holding time, both sets of data will be reported.

9.5.1. Ongoing monitoring of the LCS provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

9.5.2. A specific number of random exceedances may be allowed based on control charts kept by QA.

9.5.3. Poor performing analytes are those analytes identified as not performing well. These compounds generally have low percent recoveries and high standard deviations when the results of the LCS are compiled. Specific problems may also be noted by the standard manufacturers. The poor performing analytes for Method 8270 are aniline, 4-chloroaniline, 3-nitroaniline, 3,3'-dichlorobenzidine, benzoic acid, benzidine, and the "Appendix IX" compounds. Batch control is not determined by these analytes, and they are considered non-control analytes.

9.6. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike/matrix spike duplicate (MS/MSD) is prepared and analyzed with every batch of samples. The MS/MSD is spiked with the same subset of analytes as the LCS (See Table 5). Compare the percent recovery and relative percent difference (RPD) to that in the laboratory specific historically generated limits.

- If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in the Laboratory Control Sample (LCS). Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented.
- If the recovery for any component is outside QC limits for both the matrix spike/spike duplicate and the LCS, the laboratory is out of control and corrective action must be taken. Corrective action will normally include re-preparation and reanalysis of the batch.
- If a MS/MSD is not possible due to limited sample, then a LCS duplicate may be analyzed if required by client or program. RPD of the LCS and LCSD are compared to the matrix spike limits.
- The matrix spike/duplicate must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out.

9.7. Surrogates

9.7.1. Every sample, blank, and QC sample is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining whether the

concentration (measured as percent recovery) falls within the required recovery limits. The compounds routinely included in the surrogate spiking solution, along with recommended standard concentrations, are listed in Table 6.

9.7.2. Corrective actions for surrogate failures in MB, LCS, or LCSD (batch QC samples)

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem.
- Reanalyze the QC sample and/or reanalyze all samples in the QC batch.

Note: Unless otherwise specified by the client, it may be possible to report qualified results if method QC surrogate recoveries are biased high and analytes were not detected in the field samples. However, all other QC requirements would have to be met and the failure would have to be noted as an NCM.

9.7.3. Corrective actions for surrogate failures in field samples or MS/MSD:

- Check calculation and instrument performance.
- Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem.
- Evaluate objective evidence of matrix interference (e.g. heterogeneous sample, interfering compounds seen on chromatograms, or interference demonstrated by prior analyses);
- consult with the client in the event of low bias (as evidenced by low recoveries) in conjunction with possible matrix effect;
- re-analyze or re-prepare the affected samples;
- and document the failure and note it in the final report

Note: Some client programs require reanalysis to confirm matrix interferences. Check special project instructions for this corrective action.

The decision to reanalyze or flag the data should be made in consultation with the client. It is only necessary to re-prepare/reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect.

9.7.4. If the sample with surrogate recoveries outside the recovery limits was a sample used for an MS/MSD and the surrogate recoveries in the MS/MSD are also outside of the control limits, then the sample, the MS, and the MSD do not require reanalysis as this phenomenon would indicate a possible matrix problem.

9.7.5. If the sample is reanalyzed and the surrogate recoveries in the reanalysis are

acceptable, then the problem was within the analyst's control and only the reanalyzed data should be reported. (Unless the reanalysis was outside holding times, in which case reporting both sets of results may be appropriate.)

9.7.6. If the reanalysis does confirm the original results, the sample will be re-extracted. If the re-extraction confirms, the original analysis is reported and the data flagged as estimated due to matrix effect. If re-extraction does not confirm (all surrogates pass in the re-extraction), only the re-extraction is reported (unless the re-extraction is outside holding times, in which case both sets of results are reported.

9.8. Internal Standards

Internal standards (IS) are components similar in nature to the analytes of interest. These are added to every sample (including QC aliquots) and standard analyzed. The purpose is to enable calculations based on internal standard methodology. Internal standard response is monitored to verify that instrument performance is acceptable. Criteria for standards are delineated in Section 10 and must be met before sample analysis can start.

Internal standards in samples are monitored for instrument drift. If the internal standard data indicate instrument failure, the samples may require reanalysis. If IS response is affected by matrix effects, the impact on sample data is evaluated and the data is flagged appropriately.

9.8.1. Any samples that do not meet the same internal standard criteria set forth for the continuing calibration (Section 10.5) as compared to the Initial Calibration (ICAL) must be evaluated for validity (HSL samples to HSL ICAL, AP9 samples to AP9 ICAL.) Alternatively, the internal standards in the samples may be compared to the response of the daily CCV, on a per batch basis, to meet client or program requirements. Evaluation may include re-analysis, unless there is obvious matrix interference. If the change in internal standard response is a matrix effect confined to an individual sample (and not due to instrument drift) reanalysis may not be necessary, but should be verified by the department manager or client. Any internal standard responses outside the criteria should be noted in the case narrative. If the change in internal standard response is due to instrumental problems, all affected samples must be reanalyzed after the problem is corrected.

9.9. Nonconformance and Corrective Action

Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the facility QA Manager.

9.10. Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries should be developed to address these requirements.

9.11. QC Program

- Further details of QC and corrective action guidelines are presented in the QC Program document (WS-PQA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION

10.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)".

10.2. Summary

The instrument is tuned for DFTPP, calibrated initially with a minimum five-point calibration curve, and verified each 12-hour shift with one or more continuing calibration standard(s). Recommended instrument conditions are listed in Table 2.

10.3. All standards and extracts are allowed to warm to room temperature before injecting.

10.4. Instrument Tuning

At the beginning of every twelve-hour shift when analyses are to be performed, the GC/MS system must be checked to see if acceptable performance criteria (Table 3) are achieved for DFTPP (decafluorotriphenylphosphine).

10.4.1. Inject 50 ng of the GC/MS tuning standard (Section 7.4) into the GC/MS system. Obtain a background-corrected mass spectrum of DFTPP and confirm that all the key m/z criteria in Table 3 are achieved. If all the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are achieved. The performance criteria must be achieved before any samples, blanks, or standards are analyzed.

10.4.1.1. Evaluate the mass spectrum for DFTPP either at the apex of the peak, or ± 1 scan from the apex. Alternatively, average the mass spectra from 1 scan before the apex to 1 scan following the apex.

10.4.2. The GC/MS tuning standard should also be used to evaluate the inertness of the chromatographic system.

10.4.2.1. Benzidine and pentachlorophenol should not exhibit excessive tailing. Tailing must be ≤ 3% for benzidine and ≤ 5% for pentachlorophenol. Refer to Section 12 for the appropriate

calculations.

10.4.2.2. DDT must be included in the tuning standard, and its breakdown must be < 20%. Refer to Section 12 for the appropriate calculations.

10.5. Initial Calibration

10.5.1. Internal Standard Calibration Procedure: Internal standards are listed in Table 7. Use the base peak m/z as the primary m/z for quantitation of the standards, as noted in Table 4. If interferences are noted, use one of the next two most intense masses for quantitation.

10.5.2. Compounds should be assigned to the IS with the closest retention time.

10.5.3. Prepare calibration standards to generate a multi-point curve for each parameter of interest. A minimum of five standards is required to generate a multi-point calibration quantitated based on average relative response factors or linear regression. A minimum of six standards is required to generate a multi-point calibration based on non-linear curve fits (quadratic). In general, five standards are used for selected compounds known to exhibit poor response or poor chromatography at low concentrations, and all six standards are used for the remaining compounds. Compounds and the required calibration standards are identified in Tables 9 and 10.

10.5.4. Analyze each calibration standard and tabulate the area of the primary characteristic m/z against concentration for each compound and internal standard. Calculate response factors (RF), average response factors, and the percent RSD of the response factors for each compound using the equations in Section 12 and verify that the CCC and SPCC criteria in Section 10.4.5 and 10.4.6 are met. **No sample analysis may be performed unless these criteria are met.**

10.5.5. System Performance Check Compounds (SPCCs): The minimum average RRF for semivolatile SPCCs is 0.050. If the minimum response factors are not met, the system must be evaluated and corrective action must be taken before sample analysis begins. Some possible problems are standard mixture degradation, injection port inlet contamination, contamination at the front end of the analytical column, and active sites in the column or chromatographic system. This check must be met before analysis begins.

SPCC Compounds:
n-nitroso-di-n-propylamine
Hexachlorocyclopentadiene
2,4-Dinitrophenol
4-Nitrophenol

10.5.6. Calibration Check Compounds (CCCs): The %RSD of the response factors for

each CCC in the initial calibration must be less than 30% for the initial calibration to be considered valid. This criterion must be met before sample analysis begins. Problems similar to those listed under SPCCs could affect this criterion.

10.5.6.1. If none of the CCCs are required analytes, evaluate the calibration curve per Section 10.4.7, or project specific calibration specifications must be agreed with the client.

10.5.6.2. CCC Compounds:

Phenol
Acenaphthene
1,4-Dichlorobenzene
n-nitrosodiphenylamine
2-Nitrophenol
Pentachlorophenol
2,4-Dichlorophenol
Fluoranthene
Hexachlorobutadiene
Di-n-octylphthalate
4-Chloro-3-methylphenol
Benzo(a)pyrene
2,4,6-Trichlorophenol

10.5.7. Evaluate the %RSD of each analyte.

10.5.7.1. If the %RSD is ≤ 15% for a compound, the average relative response factor is used to quantitate that compound.

10.5.7.2. If the %RSD is > 15% for a compound, attempt a linear curve fit. Linear curve fits must have a correlation coefficient (r) of ≥ 0.995, or a coefficient of determination (r^2) of ≥ 0.990. In addition, the y intercept (listed as "b" on the Target ICAL summary page) must be within $\pm$1/2(RL/ISTD). If the intercept exceeds this criterion, false positives or negatives could result. If the RL is elevated for client or project requirements, use the default RL in the calculation.

Note: The RL value must be in terms of the amount "on-column" on the instrument.

10.5.7.3. If the linear fit does not meet criteria, a quadratic curve fit may be attempted. The coefficient of determination (r^2) must be ≥ 0.990 and the y intercept (listed as "b" on the Target ICAL summary page) must be within $\pm$1/2(RL/ISTD). If the intercept exceeds this criterion, false positives or negatives

could result. In this case, use the force through zero option (per Method 8000C.) If the RL is elevated for client or project requirements, use the default RL in the calculation

Note: The RL value must be in terms of the amount "on-column" on the instrument.

10.5.8. Weighting of Data Points

In a linear or quadratic calibration fit, the points at the lower end of the calibration curve have less weight in determining the curve generated than points at the high concentration end of the curve. However, in environmental analysis, accuracy at the low end of the curve is very important. For this reason it is preferable to increase the weighting of the lower concentration points. $1/Concentration^2$ weighting (often called $1/X^2$ weighting) will improve accuracy at the low end of the curve and should be used if the data system has this capability.

10.5.9. Initial calibration verification standard (ICV): When available, a second source calibration standard is analyzed with the initial calibration curve. Each compound of the ICV must be within ± 25% of its expected value, with the following exceptions:

Benzidine Analytes: ≤ ± 50%D
Benzoic Acid: ≤ ± 50%D
2,2'-Oxybis (1-chloropropane): ≤ ± 30%D
Appendix IX analytes: ≤ ± 35%D
Some programs may specify different criteria, such as ≤ ± 25 %D for all analytes for AFCEE or DOD. Check QAPP requirements, or ensure that the client is aware of exceptions.

Corrective actions for a failed ICV include:

- Rerun the ICV.
- Remake or acquire a new ICV.
- Evaluate instrument conditions.
- Evaluated the initial calibration standards.
- Narrate all affected data

10.5.10. If time remains in the 12-hour period initiated by the DFTPP injection before the initial calibration, samples may be analyzed. Otherwise, proceed to Section 10.5.

10.5.11. Quantitation is performed using the calibration curve or average response factor from the initial curve, not the continuing calibration

10.6. Continuing Calibration

10.6.1. At the start of each 12-hour period, the GC/MS tuning standard must be analyzed. A 50 ng injection of DFTPP must result in a mass spectrum for DFTPP, which meets the criteria given in Table 3.

10.6.2. Following a successful DFTPP analysis the continuing calibration standard(s) are analyzed. The standards must contain all semivolatile analytes, including all required surrogates. A mid level calibration standard is used for the continuing calibration. Note: use the 20 ng, 50 ng, 80 ng, or 120ng standard for the mid level standard. Whichever level is chosen, analyst must ensure that all quality control comparisons in 10.5.3 are measured are against the same level in the Initial Calibration.

10.6.3. The following criteria must be met for the continuing calibration to be acceptable:

- The SPCC compounds must have a response factor of ≥ 0.05.
- The percent difference or drift of the CCC compounds from the initial calibration must be ≤ 20%. (See Section 12 for calculations) The % drift of all non-CCC and non-SPCC analytes must be < 50% (20% for AFCEE or DOD, or predetermined exceptions). Non-CCC analytes above 15 %D are tracked for possible future corrective action.
- The internal standard response must be within 50-200% of the response in the same concentration level of the initial calibration.
- The internal standard retention times must be within 30 seconds of the retention times in the mid-level of the initial calibration, or retention times are updated

10.6.3.1. If not all of the CCCs are required analytes for a project, all analytes in the project list must be ≤ 20% D, or project specific calibration specifications must be agreed with the client.

10.6.4. If the CCCs or the SPCCs do not meet the criteria in Section 10.5.3, the system must be evaluated and corrective action must be taken. The DFTPP tune and continuing calibration must be acceptable before analysis begins.

10.6.5. Once the above criteria have been met, sample analysis may begin. Initial calibration average RFs (or the calibration curve) will be used for sample quantitation, not the continuing calibration RFs. Analysis may proceed until 12 hours from the injection of the DFTPP have passed. (A sample injected less than 12 hours after the DFTPP is acceptable.).

11. PROCEDURE

11.1. Procedural Variations

One-time procedural variations are allowed only if deemed necessary in the professional judgment of a supervisor to accommodate variation in sample matrix, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and approved by a supervisor or group leader and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file. Any unauthorized deviations from this procedure must also be documented as a non-conformance, with a cause and corrective action described.

11.2. Sample Preparation

Samples are prepared following SOP WS-OP-0001 or WS-OP-0006.

11.3. Sample Analysis Procedure

11.3.1. Calibrate the instrument as described in Section 10. Depending on the target compounds required by the client, it might be necessary to use more than one calibration standard.

11.3.2. All samples must be analyzed using the same instrument conditions as the preceding continuing calibration standard.

11.3.3. Add internal standard to the extract to result in 40 ng injected on column (for example, 20 µL internal standard solution in 1.0 mL of extract for a 1 µL injection). Mix thoroughly before injection into the instrument.

11.3.4. Inject the sample extract into the GC/MS system using the same injection technique as used for the standards.

11.3.5. The data system will determine the concentration of each analyte in the extract using calculations equivalent to those in Section 12. Quantitation is based on the initial calibration, not the continuing calibration.

11.3.6. Identified compounds are reviewed for proper integration. Manual integrations are performed if necessary and are documented by the analyst or automatically by the data system. See CA-Q-S-002 for Manual Integration procedures.

11.3.7. Target compounds identified by the data system are evaluated using the criteria listed in Section 12.1.

11.3.8. Library searches of peaks present in the chromatogram that are not target compounds (Tentatively Identified Compounds, TIC) may be performed if required by the client. They are evaluated using the criteria in Section 12.3.

11.4. Dilutions

If the response for any compound exceeds the working range of the GC/MS system, a dilution of the extract is prepared and analyzed. An appropriate dilution should be targeted to be in the upper half of the calibration range. Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the reporting limit and the matrix allows for analysis at a lesser dilution, the sample should be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

11.4.1. Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and the baseline rise is less than the height of the internal standards, or if individual non-target peaks are less than two times the height of the internal standards, the sample should be reanalyzed at a more concentrated dilution. This requirement is approximate and subject to analyst judgment. For example, samples containing organic acids may need to be analyzed at a higher dilution to avoid destroying the column.

11.4.2. Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will only be reported at client request.

11.4.3. Each time the sample extract is diluted, internal standard solution must be added to maintain a final concentration of 40 μg/mL for each internal standard component. See Table 8 for guidance as to solution volumes when diluting.

11.5. Perform all qualitative and quantitative measurements. When the extracts are not being used for analyses, refrigerate them at -10 to -20°C, protected from light in screw cap vials equipped with unpierced Teflon lined septa.

11.6. Retention Time Criteria for Samples

If the retention time for any internal standard changes by more than 0.5 minutes from the last continuing calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

11.6.1. If the retention time of any internal standard in any sample varies by more than 0.1 minute from the preceding continuing calibration standard, the data must be carefully evaluated to ensure that no analytes have shifted outside their retention time windows.

11.7. Percent Moisture

Analytical results may be reported as dry or wet weight, as required by the client. Percent moisture must be determined if results will be reported as dry weight. Refer to SOP WS-OP-0013 for determination of percent moisture.

11.8. Troubleshooting Guide

11.8.1. Daily Instrument Maintenance

In addition to the checks listed in the instrument maintenance schedule in the TestAmerica West Sacramento Quality Assurance Manual(QAM), the following daily maintenance should be performed.

- Clip column as necessary.
- Install new or cleaned injection port liner as necessary.
- Install new septum as necessary.
- Perform mass calibration as necessary.

11.8.2. Major Maintenance

- A new initial calibration is necessary following major maintenance. Major maintenance includes changing the column, cleaning the ion volume or repeller, cleaning the source, and replacing the multiplier. Refer to the manufacturer's manual for specific guidance.

12. CALCULATIONS/DATA REDUCTION

12.1. Qualitative Identification

An analyte is identified by retention time and by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard reference may be obtained on the user's GC/MS by analysis of the calibration standards or from the NIST library. Two criteria must be satisfied to verify identification: (1) elution of sample component at the same GC retention time as the standard component; and (2) correspondence of the sample component and the standard component characteristic ions.

Note: Care must be taken to ensure that spectral distortion due to co-elution is evaluated.

- The sample component retention time must compare to within ± 0.2 min. of the retention time of the standard component. For reference, the standard must be run within the same twelve hours as the sample.
- All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) should be present in the sample spectrum.

- The characteristic ions of a compound must maximize in the same scan or within one scan of each other.
- The relative intensities of ions should agree to within ±30% between the standard and sample spectra. Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20% and 80%.

12.1.1. If a compound cannot be verified by all the above criteria, but in the technical judgment of the analyst the identification is correct, the analyst shall report that identification and proceed with quantitation.

12.2. Mass Chromatogram Searches.

Certain compounds are unstable in the calibration standard and cannot be calibrated in the normal way. In particular, the compounds hexachlorophene, kepone and famphur fall into this category, and are required for Appendix IX analysis. For these analytes a mass chromatogram search is made.

12.2.1. Display the mass chromatograms for the masses below for the region of the chromatogram from at least 3 minutes before chrysene-d12 to at least 4 minutes after chrysene-d12. If peaks for all ions coincide then the analyst evaluates the spectrum for the presence of hexachlorophene, kepone, and/or famphur. No quantitation is possible.

Compound	Masses Monitored		
Hexachlorophene	196	198	
Kepone	272	274	237
Famphur	218	125	93

12.3. For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the type of analyses being conducted. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual comparison of sample spectra with the nearest library searches shall the mass spectral interpretation specialist assign a tentative identification. Guidelines for making tentative identification are:

- Relative intensities of major ions in the reference spectrum (ions >10% of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ±20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance should be between 30% and 70%.)
- Molecular ions present in the reference spectrum should be present in the sample spectrum.

- Ions present in the sample spectrum, but not in the reference spectrum, should be reviewed for possible background contamination or presence of coeluting compounds.
- Ions present in the reference spectrum, but not in the sample spectrum, should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks. Data system library reduction programs can sometimes create these discrepancies.
- Automatic background subtraction can severely distort spectra from samples with unresolved hydrocarbons.
- Any compound identified by the library search with a probability of 80% or less will be reported as UNKNOWN only. Any compound identified by the library search with 80% to 100% probability will be reported as the compound selected by the library search program. The only exception will be Aldol Condensate products which will be reported as "Aldol Condensate Product", and not by the analyte name.

Note: For samples that request a specific analyte list, and a TIC evaluation, any analytes detected that are not on the specific analyte list, but are part of laboratory calibration, are to be reported from the calibration, not library search.

12.4. Anyone evaluating data is trained to know how to handle isomers with identical mass spectra and close elution times. These include:

Chloroanilines
Dichlorobenzenes
Dinitrotoluenes
Methylphenols
Trichlorophenols
Phenanthrene, Anthracene
Fluoranthene, Pyrene
Benzo(b) and (k)fluoranthene
Chrysene, Benzo(a)anthracene

Extra precautions concerning these compounds are to more closely scrutinize retention time vs. the calibration standard and also to check that all isomers have distinct retention times. In particular, Benzo(b) and (k)fluoranthene may present difficulty in separation at higher levels. They may be reported together if the client does not require the separation.

A second category of problem compounds would be the poor responders or compounds that chromatograph poorly. Included in this category would be:

a,a-Dimethylphenethylamine
Benzoic acid
Chloroanilines
Nitroanilines
2,4-Dinitrophenol

4-Nitrophenol
Pentachlorophenol
3,3'-Dichlorobenzidine
Benzyl alcohol
4,6-Dinitro-2-methylphenol

Manually checking the integrations is appropriate for these compounds.

12.5. Calculations

More detailed information on fitting calculations are available from CA-Q-S-005 Calibration Curves (General).

12.5.1. Percent Relative Standard Deviation for Initial Calibration

EQUATION 1

$$\%\text{RSD} = \frac{\text{SD}}{\overline{\text{RF}}} \times 100$$

Where:

$\overline{RF}$ = Mean of RFs from initial calibration for a compound,

SD = Standard Deviation of RFs from the initial calibration for that compound, calculated as:

EQUATION 2

$$\sqrt{\sum_{i=1}^{N} \frac{\left(RFi - \overline{RF}\right)^2}{N-1}}$$

Where:

RFi = RF for each of the calibration levels

N = Number of RF levels

12.5.2. Continuing Calibration Percent Drift

EQUATION 3

$$\%\text{Drift} = \frac{C_{found} - C_{actual}}{C_{actual}} \times 100\%$$

Where:

C_{actual} = Known concentration in standard

C_{found} = Measured concentration using selected quantitation method

12.5.3. Concentration in the extract

The concentration of each identified analyte and surrogate in the extract is calculated from the linear or quadratic curve fitted to the initial calibration points, or from the average RF of the initial calibration. Variables for the equations below include:

C_{ex} = Concentration in extract, µg/mL

R_x = Response for analyte
R_{is} = Response for internal standard
C_{is} = Concentration of internal standard
A = Intercept
B = Slope
C = Curvature

12.5.3.1. Average Response Factor

If the average of all the %RSDs of the response factors in the initial calibration is ≤ 15%, the average response factor from the initial calibration may be used for quantitation.

EQUATION 4

$$C_{ex} = \frac{R_x C_{is}}{R_{is} \overline{RF}}$$

12.5.3.2. Linear Fit

EQUATION 5

$$C_{ex} = A + B\frac{(R_x C_{is})}{R_{is}}$$

12.5.3.3. Quadratic Fit

EQUATION 6

$$C_{ex} = \left(\frac{\frac{R_x}{R_{is}} - A}{B} \right) (C_{is})$$

12.5.4. The concentration in the sample is then calculated.

12.5.4.1. Aqueous Calculation

EQUATION 7

$$\text{Concentration, } \mu g/L = \frac{CexVt}{Vo}$$

Where:

V_t = Volume of total extract, µL, taking into account dilutions (i.e., a 1-to-10 dilution of a 1 mL extract will mean V_t = 10,000 µL. If half of the base/neutral extract and half of the acid extract are combined, V_t = 2,000.)

V_o = Volume of water extracted (mL)

12.5.4.2. Sediment/Soil, Sludge (on a dry-weight basis) and Waste (normally on a wet-weight basis:

EQUATION 8

$$\text{Concentration, } \mu g/kg = \frac{CexVt}{WsD}$$

Where:

W_s = Weight of sample extracted or diluted in grams
D = (100 - % moisture in sample)/100, for a dry weight basis or 1 for a wet weight basis

12.5.5. MS/MSD Percent Recovery Calculation.

EQUATION 9

$$\text{Matrix Spike Recovery} = \frac{S_{SR} - S_R}{S_A} \times 100\%$$

Where:

S_{SR} = Spike sample result
S_R = Sample result
S_A = Spike added

12.5.6. Relative Percent Difference calculation for the MS/MSD

EQUATION 10

$$RPD = \frac{MS_R - MSD_R}{1/2(MS_R + MSD_R)} \times 100$$

Where:

RPD = Relative percent difference
MS_R = Matrix spike result
MSD_R = Matrix spike duplicate result

12.5.7. Relative Response Factor Calculation.

EQUATION 11

$$RF = \frac{A_x C_{is}}{A_{is} C_x}$$

Where:

A_x = Area of the characteristic ion for the compound being measured
A_{is} = Area of the characteristic ion for the specific internal standard
C_x = Concentration of the compound being measured (µg/L)
C_{is} = Concentration of the specific internal standard (µg/L)

12.5.8. Calculation of TICs: The calculation of TICs (tentatively identified compounds) is identical to the above calculations with the following exceptions:

A_x= Area of the total ion chromatogram for the compound being measured
A_{is}= Area of the total ion chromatogram for the nearest internal standard without interference
RF= 1

12.5.9. Percent DDT Breakdown

EQUATION 12

$$\%\ \text{DDT breakdown} = \frac{\text{DDEarea} + \text{DDDarea}}{\text{DDTarea} + \text{DDEarea} + \text{DDarea}}$$

The total ion current areas are used for this calculation

12.5.10. Tailing Factor (From Method 625)

EQUATION 13

$$\text{Tailing Factor} = \frac{AB}{BC}$$

Where:

AB = Peak width at 10% peak height, leading line to line drawn from apex.

12.5.11. BC = Peak width at 10% peak height, line from apex to right side of peak.

13. METHOD PERFORMANCE

13.1. Method Detection Limit

Each laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in QA Policy #: CA-Q-S-006 and WS-QA-0006. MDLs are available in the Quality Assurance department.

13.2. Initial Demonstration

Each laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.2.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to the level 4 calibration standard.

13.2.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.2.3. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.3. Non-standard Analytes

For non-standard analytes, an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is analysis of an extracted standard at the reporting limit and a single point calibration.

13.4. Training Qualification

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

13.5. Data Quality Objectives (DQO). Refer to project-specific Quality Assurance plans for DQO information.

14. POLLUTION PREVENTION

All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment.

14.1. Do not allow waste solvent to evaporate in fume hoods. All solvent waste is stored in capped containers unless transfers are being made.

15. WASTE MANAGEMENT

The following waste streams are produced when this method is carried out.

15.1. Autovials contaminated with methylene chloride. As the autovials are removed from the instrument after analysis, they are collected in open containers at the instrument. After all autovials are removed, the open container must be dumped into a closed satellite collection container in a fume hood, as the punctured septa in the autovial can allow methylene chloride to evaporate into the atmosphere. The satellite collection containers are transferred to the waste disposal area when full or after no more than one year, where they are disposed through the vial eater.

16. REFERENCES/CROSS REFERENCES

16.1. SW846, Test Methods for Evaluating Solid Waste, Third Edition, Update III, December 1996, Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique, Method 8270C.

16.2. SW846, Test Methods for Evaluating Solid Waste, Third Edition, Update III, December 1996, Determinative Chromatographic Separations, Method 8000B.

16.3. SW846, Test Methods for Evaluating Solid Waste, Third Edition, Update III, March 2003, Determinative Chromatographic Separations, Method 8000C.

16.4. J. W. Eichelberger, L. E. Harris, and W. L. Budde, "Reference Compound to Calibrate Ion Abundance Measurement in Gas Chromatography/Mass Spectrometry," Analytical Chemistry, 47, 995 (1975).

16.5. Method 625, 40 CRF Part 136, Appendix A. (7-1-93)

16.6. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-13A, (1999)

17. METHOD MODIFICATIONS

17.1. Modifications from Reference Method

17.1.1. A retention time window of 0.2 minutes is used for all components, since some data systems do not have the capability of using the relative retention time units specified in the reference method.

17.1.2. The quantitation and qualifier ions for some compounds have been changed from those recommended in SW-846 in order to improve the reliability of qualitative identification.

17.1.3. Due to retention time shifts as a result of column clipping and long-lived initial calibrations, the internal standard retention time criteria for continuing calibrations has been removed.

18. ATTACHMENTS

18.1.1. Table 1- Analytes and Standard Reporting Limits

18.2. Table 2- Suggested Instrument Conditions

18.3. Table 3- DFTPP Key Ions and Ion Abundance Criteria

18.4. Table 4- Analytes in Appropriate Retention Time Order and Characteristic Ions

18.5. Table 5- LCS and MS/MSD Spiking Components and Concentrations in the Sample

18.6. Table 6- Surrogate Compounds and Spiking Levels

18.7. Table 7- Internal Standard Solution

18.8. Table 8- Dilution Guidance

18.9. Table 9- Calibration Levels, Primary Standard, µg/mL

18.10. Table 10- Calibration Levels, Appendix IX Standard, µg/mL

19. REVISION HISTORY

19.1. WS-MS-0005, Revision 4.3, Effective 8/9/2010

19.1.1. Changed Section 10.6.3 to: "The % drift for all non-CCC and non-SPCC analytes must be <50% (20% AFCEE or DOD, or predetermined exceptions).

19.1.2. Inserted not following Section 12.5: More detailed information on fitting calculations are available from CA-Q-S-005 Calibration Curves (General).

19.2. WS-MS-0005, Revision 4.2, Effective 9/04/2009

19.2.1. Added Section 1.3, "When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPP Implementation" must be checked and incorporated."

19.2.2. Inserted Section 10.1, "For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)"."

19.3. WS-MS-0005, Revision 4.1, Effective 6/19/2009

19.3.1. Updated "Air" spiking concentrations in Table 5.

19.3.2. Updated instrument operating parameters in Table 2.

19.4. WS-MS-0005, Revision 4, Effective 2/29/08

19.4.1. This SOP has been updated to the new TestAmerica format.

19.4.2. Removed the 1,4 Dioxane appendix to a separate SOP WS-MS-0011.

19.4.3. Removed the instrument conditions for the "slow run".

19.4.4. Clarified that analytes not requested as part of an analyte list but which are part of a calibration curve are to be reported from calibration standards, not library searches (note in Section 12.3).

19.5. SAC-MS-0005, Revision 3, Effective 1/3/07

19.5.1. Included a "short run" operating conditions.

19.5.2. Updated internal standard criteria.

19.6. SAC-MS-0005, Revision 2, Effective 12/16/04

19.6.1. Included directions for analysis of 1,4-Dioxane.

19.6.2. Revised maximum dilution for reporting surrogates.

19.6.3. Revised calibration schemes and criteria.

19.6.4. Revised tailing factor criteria and added calculation.

19.6.5. Added information for dealing with problematic analytes.

19.6.6. Updated EHS sections.

19.7. SAC-MS-0005, Revision 1, Revised 7/12/01

19.7.1. This SOP has been updated to reflect the change of ownership from Quanterra to STL.

19.7.2. This SOP has been modified from a "Corporate" SOP to a local SOP.

19.7.3. Directions for Method 625 have been removed.

19.7.4. The analyte list has been evaluated and verified to reflect the current lab practices.

19.7.5. The ions used for quantitation and qualification have been compared to the characteristic ion table in SW-846. Discrepancies have been flagged.

19.7.6. Included guidelines for which scans to use for evaluating DFTPP tuning criteria.

Table 1				
Analytes and Standard Reporting Limits				
Compound	CAS No.	Aqueous ug/L	Solid ug/kg	Air ug/sample
a,a-Dimethylphenethylamine	122-09-8	50	1600	50
Acenaphthene	83-32-9	10	330	10
Acenaphthylene	208-96-8	10	330	10
Acetophenone	98-86-2	10	330	10
2-Acetylaminofluorene	53-96-3	100	3300	100
4-Aminobiphenyl	92-67-1	50	1600	50
Aniline	62-53-3	10	330	10
Anthracene	120-12-7	10	330	10
Aramite	140-57-8	20	660	20
Azobenzene[2]	103-33-3	10	330	10
Benzaldehyde	100-52-7	10	330	--
Benzidine	92-87-5	100	3300	100
Benzo(a)anthracene	56-55-3	10	330	10
Benzo(b)fluoranthene	205-99-2	10	330	10
Benzo(j)fluoranthene	205-82-3	10	330	10
Benzo(k)fluoranthene	207-08-9	10	330	--
Benzoic acid	65-85-0	50	1600	150
Benzo(ghi)perylene	191-24-2	10	330	10
Benzo(a)pyrene	50-32-8	10	330	10
Benzo(e)pyrene	197-97-2	10	330	10
Benzyl alcohol	100-51-6	10	330	10
Biphenyl	92-52-4	10	330	--
bis(2-Chloroethoxy)methane	111-91-1	10	330	10
bis(2-Chloroethyl) ether	111-44-4	10	330	10
bis(2-Ethylhexyl) phthalate	117-81-7	10	330	10
4-Bromophenyl phenyl ether	101-55-3	10	330	10
Butyl benzyl phthalate	85-68-7	10	330	10
Carbazole	86-74-8	10	330	10
4-Chloroaniline	106-47-8	10	330	10
Chlorobenzilate	510-15-6	20	660	20
4-Chloro-3-methylphenol	59-50-7	10	330	50
1-Chloronaphthalene	90-13-1	10	330	--
2-Chloronaphthalene	91-58-7	10	330	10
2-Chlorophenol	95-57-8	10	330	10
4-Chlorophenyl phenyl ether	7005-72-3	10	330	10
Chrysene	218-01-9	10	330	10
Diallate	2303-16-4	20	660	20
Dibenz(a,j)acridine	224-42-0	20	660	20

Table 1				
Analytes and Standard Reporting Limits				
Compound	CAS No.	Aqueous ug/L	Solid ug/kg	Air ug/sample
Dibenz(a,h)anthracene	53-70-3	10	330	10
Dibenzofuran	132-64-9	10	330	10
Di-n-butyl phthalate	84-74-2	10	330	10
1,2-Dichlorobenzene	95-50-1	10	330	10
1,3-Dichlorobenzene	541-73-1	10	330	10
1,4-Dichlorobenzene	106-46-7	10	330	10
3,3'-Dichlorobenzidine	91-94-1	50	1600	10
2,4-Dichlorophenol	120-83-2	10	330	10
2,6-Dichlorophenol	87-65-0	10	330	10
Diethyl phthalate	84-66-2	10	330	10
Dimethoate	60-51-5	20	660	20
p-Dimethylaminoazobenzene	60-11-7	20	660	20
7,12-Dimethylbenz(a)anthracene	57-97-6	20	660	20
3,3'-Dimethylbenzidine	119-93-7	50	1600	50
2,4-Dimethylphenol	105-67-9	10	330	10
Dimethyl phthalate	131-11-3	10	330	10
1,3-Dinitrobenzene	99-65-0	10	330	10
1,4-Dinitrobenzene	100-25-4	10	330	--
4,6-Dinitro-2-methylphenol	534-52-1	50	1600	50
2,4-Dinitrophenol	51-28-5	50	1600	50
2,4-Dinitrotoluene	121-14-2	10	330	10
2,6-Dinitrotoluene	606-20-2	10	330	10
Dinoseb	88-85-7	20	660	20
Di-n-octyl phthalate	117-84-0	10	330	10
Disulfoton	298-04-4	50	1600	50
Ethyl methanesulfonate	62-50-0	10	330	10
Famphur	52-85-7	100	3300	100
Fluoranthene	206-44-0	10	330	10
Fluorene	86-73-7	10	330	10
Hexachlorobenzene	118-74-1	10	330	10
Hexachlorobutadiene	87-68-3	10	330	10
Hexachlorocyclopentadiene	77-47-4	50	1600	50
Hexachloroethane	67-72-1	10	330	10
Hexachloropropene	1888-71-7	10	3300	10
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10
Isodrin	465-73-6	20	660	20
Isophorone	78-59-1	10	330	10
Isosafrole	120-58-1	20	660	20
Kepone	143-50-0	100	3300	100

Table 1				
Analytes and Standard Reporting Limits				
Compound	CAS No.	Aqueous ug/L	Solid ug/kg	Air ug/sample
Methapyrilene	91-80-5	50	1600	50
3-Methylcholanthrene	56-49-5	20	660	20
Methyl methanesulfonate	66-27-3	10	330	10
2-Methylnaphthalene	91-57-6	10	330	10
1-Methylnaphthalene	90-12-0	10	330	--
Methyl parathion	298-00-0	50	1600	50
2-Methylphenol	95-48-7	10	330	20
3-Methylphenol	108-39-4	10	330	50
4-Methylphenol	106-44-5	10	330	20
3-Methylphenol & 4-Methylphenol	65794-96-9	20	660	50
Naphthalene	91-20-3	10	330	10
1,4-Naphthoquinone	130-15-4	50	1600	50
1-Naphthylamine	134-32-7	10	330	10
2-Naphthylamine	91-59-8	10	330	10
2-Nitroaniline	88-74-4	50	1600	10
3-Nitroaniline	99-09-2	50	1600	10
4-Nitroaniline	100-01-6	50	1600	50
Nitrobenzene	98-95-3	10	330	10
2-Nitrophenol	88-75-5	10	330	50
4-Nitrophenol	100-02-7	50	1600	50
4-Nitroquinoline-1-oxide	56-57-5	100	3300	100
n-Nitrosodi-n-butylamine	924-16-3	10	330	10
n-Nitrosodiethylamine	55-18-5	10	330	10
n-Nitrosodimethylamine	62-75-9	10	330	10
n-Nitrosodiphenylamine[3]	86-30-6	10	330	10
n-Nitrosodi-n-propylamine	621-64-7	10	330	10
n-Nitrosomethylethylamine	10595-95-6	10	330	10
n-Nitrosomorpholine	59-89-2	10	330	10
n-Nitrosopiperidine	100-75-4	10	330	10
n-Nitrosopyrrolidine	930-55-2	10	330	10
5-Nitro-o-toluidine	99-55-8	20	660	20
2,2'-oxybis(1-Chloropropane)[1]	108-60-1	10	330	10
Parathion	56-38-2	50	1600	50
Pentachlorobenzene	608-93-5	20	660	20
Pentachloroethane	76-01-7	50	1600	50
Pentachloronitrobenzene	82-68-8	50	1600	50
Pentachlorophenol	87-86-5	50	1600	50
Phenacetin	62-44-2	20	660	20
Phenanthrene	85-01-8	10	330	10

Table 1				
Analytes and Standard Reporting Limits				
Compound	CAS No.	Aqueous ug/L	Solid ug/kg	Air ug/sample
Phenol	108-95-2	10	330	50
1,4-Phenylenediamine	106-50-3	100	3300	100
Phorate	298-02-2	50	1600	50
2-Picoline	109-06-8	20	660	20
Pronamide	23950-58-5	20	660	20
Pyrene	129-00-0	10	330	10
Pyridine	110-86-1	20	660	20
Safrole	94-59-7	20	660	20
Sulfotepp	3689-24-5	50	1600	50
1,2,4,5-Tetrachlorobenzene	95-94-3	10	330	10
2,3,4,6-Tetrachlorophenol	58-90-2	50	1600	50
2,3,5,6-Tetrachlorophenol	935-95-5	50	1600	--
Thionazin	297-97-2	50	1600	50
o-Toluidine	95-53-4	20	660	20
1,2,4-Trichlorobenzene	120-82-1	10	330	10
2,4,5-Trichlorophenol	95-95-4	10	330	10
2,4,6-Trichlorophenol	88-06-2	10	330	50
O,O,O-Triethyl phosphorothioate	126-68-1	50	1600	50
1,3,5-Trinitrobenzene	99-35-4	50	1600	50

[1] 2,2'oxybis(1-chloropropane) was formerly known as bis(2-chloroisopropyl)ether

[2] Azobenzene is formed by decomposition of 1,2-diphenlyhydrazine. If 1,2-diphenylhydrazine is requested, it will be analyzed as azobenzene.

[3] Diphenylamine is a required compound for Appendix IX. N-nitrosodiphenylamine decomposes in the injection port to form diphenylamine. Therefore these two compounds cannot be distinguished. Diphenylamine is not included in the calibration standard.

Note: Hexachlorophene is a required analyte for Appendix IX. This compound is not stable, and therefore not included in the calibration standard. The characteristic ions for hexachlorophene are searched for in the chromatogram. (See Section 12.2.1)

Table 2	
Suggested Instrumental Conditions	
Mass Range	35-500 amu
Scan Time	≤1 second/scan
Initial Column Temperature/Hold Time	60°C for 1 minute
Column Temperature Program	Ramp at 20 °C/min to 190 °C, hold for 0.00 min Ramp at 13 °C/min to 310 °C, hold for 2.00 min. Ramp at 30 °C/min to 320 °C, hold for 1.00 min
Final Column Temperature/Hold Time	320°C (until at least one minute after benzo(g,h,i)perylene has eluted)
Injector Temperature	250 - 300°C
Transfer Line Temperature	250 - 300°C
Source Temperature	According to manufacturer's specifications
Injector	Grob-type, split/splitless
Sample Volume	1 or 2 µl
Carrier Gas	Helium at 30 cm/sec

Table 3
DFTPP Key Ions and Ion Abundance Criteria

Mass	Ion Abundance Criteria
51	30 - 60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40 - 60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5 - 9% of mass 198
275	10 - 30% of mass 198
365	>1% of mass 198
441	Present, but less than mass 443
442	>40% of mass 198
443	17 - 23% of mass 442

Table 4				
Analytes in Approximate Retention Time Order and Characteristic Ions				
	Approximate Retention Time	Primary ion	Secondary ion	Tertiary ion
Internal Standards				
1,4-Dichlorobenzene-d4	4.045	152	150	115
Naphthalene-d8	5.432	136	68	
Acenaphthene-d10	7.512	164	162	160
Phenanthrene-d10	9.457	188	94	80

Table 4				
Analytes in Approximate Retention Time Order and Characteristic Ions				
	Approximate Retention Time	Primary ion	Secondary ion	Tertiary ion
Chrysene-d12	13.855	240	120	236
Perylene-d12	16.245	264	260	265
Surrogates				
2-Fluorophenol	2.907	112	64	
Phenol-d5	3.735	99	71	
2-Chlorophenol-d4	3.859	132	68	134
1,2-Dichlorobenzene-d4	4.242	152	150	
Nitrobenzene-d5	4.666	82	128	54
2-Fluorobiphenyl	6.725	172	171	170
2,4,6-Tribromophenol	8.536	330	332	141
Terphenyl-d14	12.065	244	122	212
Analytes				
n-Nitrosodimethylamine[1,2]	2.006	74	42	44
Pyridine[3]	2.017	79	78	
2-Picoline	2.433	93	66	92
n-Nitrosomethylethylamine[2]	2.516	88	35	
Methyl methanesulfonate	2.754	80	79	65
Benzaldehyde	3.582	106	105	77
n-Nitrosodiethylamine	3.064	102	56	57
Ethyl methanesulfonate	3.323	79	109	97
Aniline	3.776	93	66	65
Phenol	3.755	94	65	66
Pentachloroethane	3.706	117	119	
bis(2-chloroethyl)ether	3.828	93	63	95
2-Chlorophenol	3.879	128	64	130
1,3-Dichlorobenzene	4.014	146	148	111
1,4-Dichlorobenzene	4.066	146	148	111
Benzyl Alcohol	4.221	108	79	77
1,2-Dichlorobenzene	4.252	146	148	113
2-Methylphenol[1,2]	4.345	108	107	79
2,2'-oxybis(1-Chloropropane)	4.366	45	121	77
4-Methylphenol[1,2]	4.511	108	107	79
Acetophenone[2]	4.430	105	77	51
Hexachloroethane[2]	4.562	117	201	119
n-Nitrosodi-n-propylamine	4.542	70	42	130
n-Nitrosopyrrolidine	4.430	100	41	42
3-Methylphenol[1,2]	4.461	108	107	79
o-Toluidine	4.482	106	107	77
n-Nitrosomorpholine[3]	4.451	56	86	116

Table 4				
Analytes in Approximate Retention Time Order and Characteristic Ions				
	Approximate Retention Time	Primary ion	Secondary ion	Tertiary ion
Nitrobenzene	4.687	77	123	65
n-Nitrosopiperidine[1,2]	4.782	42	114	55
Isophorone	4.945	82	95	138
2-Nitrophenol	5.028	139	109	65
2,4-Dimethyphenol	5.090	107	122	121
bis(2-chloroethoxy)methane	5.194	93	95	123
o,o,o-TEPT[3]	5.144	198	121	93
2,4-Dichlorophenol	5.297	162	164	98
Benzoic Acid	5.349	122	105	77
1,2,4-Trichlorobenzene	5.380	180	182	145
Naphthalene	5.452	128	129	127
a-,a-Dimethylphenethylamine	5.196	58	91	42
4-Chloroaniline	5.545	127	129	
2,6-Dichlorophenol[3]	5.506	162	164	98
Hexachloropropene	5.537	213	211	215
Hexachlorobutadiene	5.659	225	223	227
p-Phenylenediamine[2]	5.910	108	80	107
n-Nitroso-di-n-butylamine	5.910	84	57	41
4-Chloro-3-methylphenol	6.125	107	144	142
Safrole[2]	6.117	162	131	104
Biphenyl[3]	6.769	154	153	76
2-Methylnaphthalene	6.249	142	141	115
1-Chloronaphthalene	6.810	162	127	164
1-Methylnaphthalene	6.324	142	141	115
Hexachlorocyclopentadiene	6.518	237	235	272
1,2,4,5-Tetrachlorobenzene	6.448	216	214	218
Isosafrole#1	6.469	162	131	104
2,4,6-Trichlorophenol	6.632	196	198	200
2,4,5-Trichlorphenol	6.673	196	198	200
2-Chloronaphthalene	6.829	162	127	164
Isosafrole#2	6.727	162	131	104
2-Nitroaniline	7.015	65	92	138
1,4-Naphthoquinone	6.996	158	102	104
1,3-Dinitrobenzene	7.100	168	75	
Dimethylphthalate	7.274	163	194	164
Acenaphthylene	7.325	152	151	153
1,4-Dinitrobenzene	7.234	168	75	
2,6-Dinitrotoluene	7.832	165	63	89
1,2-Dinitrobenzene	7.369	168	63	50

Table 4				
Analytes in Approximate Retention Time Order and Characteristic Ions				
	Approximate Retention Time	Primary ion	Secondary ion	Tertiary ion
3-Nitroaniline	7.522	138	108	92
Acenaphthene[1,2]	7.553	153	154	152
2,4-Dinitrophenol	7.646	184	63	154
Dibenzofuran	7.750	168	139	84
4-Nitrophenol[1,2]	7.770	109	139	65
Pentachlorobenzene	7.721	250	252	248
2,4-Dinitrotoluene	8.184	165	63	89
1-Naphthylamine[2]	7.793	143	115	116
2,3,5,6-Tetrachlorophenol	7.855	232	230	131
2-Naphthylamine	7.897	143	115	116
2,3,4,6-Tetrachlorophenol[3]	7.917	232	230	131
Fluorene	8.184	166	165	167
Diethylphthalate[3]	8.164	149	177	150
4-Chlorophenyl phenyl ether	8.195	204	206	141
4-Nitroaniline[3]	8.329	138	108	92
5-Nitro-o-toluidine	8.207	152	106	77
Thionazin[1]	8.186	97	96	143
4,6-Dinitro-2-methylphenol[1,2]	8.370	198	182	77
n-Nitrosodiphenylamine	8.381	169	168	167
Diphenylamine	8.300	169	168	167
Azobenzene	8.402	77	105	182
4-Bromophenyl phenyl ether	8.836	248	250	141
Sulfotepp[3]	8.673	97	322	202
Diallate 1	8.745	86	234	
1,3,5-Trinitrobenzene[1,2]	8.766	120	75	213
Phorate[1,2]	8.756	121	75	97
Diallate 2	8.859	86	234	
Phenacetin	8.797	108	109	179
Hexachlorobenzene	9.033	284	142	249
Dimethoate	9.004	87	93	125
Pentachlorophenol	9.302	266	264	268
4-Aminobiphenyl	9.159	169	168	170
Pentachloronitrobenzene[1,2]	9.345	295	237	142
Pronamide	9.325	173	175	145
Phenanthrene	9.498	178	179	176
Anthracene	9.571	178	176	179
Disulfoton	9.501	88	97	89
2-sec-Butyl-4,6-dinitrophenol	9.532	211	163	147
Carbazole[3]	9.830	167	166	139

Table 4				
Analytes in Approximate Retention Time Order and Characteristic Ions				
	Approximate Retention Time	Primary ion	Secondary ion	Tertiary ion
Methyl parathion	10.070	109	125	263
Di-n-butylphthalate	10.502	149	150	104
Hexachlorophene	10.600	196	198	406
4-Nitroquinoline-1-oxide[1,2]	10.680	190	174	101
Parathion	10.711	109	97	291
Methapyrilene[1,2]	10.877	58	97	72
Isodrin	11.063	193	66	195
Fluoranthene[2]	11.361	202	101	100
Benzidine	11.640	184	92	185
Pyrene[2]	11.734	202	101	100
Aramite#1[2]	12.057	185	135	91
Aramite#2[2]	12.191	185	91	135
p-Dimethylaminoazobenzene[1,2]	12.274	120	225	77
p-Chlorobenzilate	12.388	251	139	253
Kepone	12.802	272	274	237
3,3'-Dimethylbenzidine	12.924	212	106	196
Famphur	12.864	218	125	93
Butylbenzylphthalate	13.037	149	91	206
2-Acetylaminofluorene	13.329	181	180	223
Benzo(a)anthracene	13.834	228	229	226
Chrysene	13.917	228	226	229
3,3'-Dichlorobenzidine	13.876	252	254	126
bis(2-Ethylhexyl)phthalate	14.145	149	167	279
Di-n-octylphthalate	15.2000	149	167	43
Benzo(j)fluoranthene	15.596	252	126	250
Benzo(b)fluoranthene	15.676	252	253	125
Benzo(k)fluoranthene	15.718	252	253	125
7,12-Dimethylbenz(a)anthracene[2]	15.606	256	241	257
Benzo(e)pyrene[3]	16.090	252	126	250
Benzo(a)pyrene	16.173	252	253	125
3-Methylcholanthrene[2]	16.651	268	253	267
Dibenz(a,j)acridine	17.531	279	280	277
Indeno(1,2,3-cd)pyrene	17.911	276	138	
Dibenzo(a,h)anthracene	17.953	278	139	279
Benzo(g,h,i)perylene	18.356	276	138	277

1 Primary ion differs from Table 1 of Method 8270C (Characteristic Ions).

2 One of more confirmation ions differs from Table 1 of Method 8270C.

3 Compound is not listed in Table 1 of Method 8270C

Table 5			
LCS and MS/SD Spiking Components and Concentrations in the Sample			
Compound	Aqueous (µg/L)	Solid (µg/kg)	Air (µg)
Acenaphthene	100	3330	100
Acenaphthylene	100	3330	100
Anthracene	100	3330	100
Benz(a)anthracene	100	3330	100
Benzo(b)fluoranthene	100	3330	100
Benzo(k)fluoranthene	100	3330	100
Benzoic acid[1]	100	3330	100
Benzo(ghi)perylene	100	3330	100
Benzo(a)pyrene	100	3330	100
Benzyl alcohol	100	3330	100
bis(2-Chloroethoxy)methane	100	3330	100
bis(2-Chloroethyl) ether	100	3330	100
bis(2-Ethylhexyl) phthalate	100	3330	100
4-Bromophenyl phenyl ether	100	3330	100
Butyl benzyl phthalate	100	3330	100
Carbazole	100	3330	100
4-Chloroaniline[1]	100	3330	100
4-Chloro-3-methylphenol	100	3330	100
2-Chloronaphthalene	100	3330	100
2-Chlorophenol	100	3330	100
4-Chlorophenyl phenyl ether	100	3330	100
Chrysene	100	3330	100
Dibenz(a,h)anthracene	100	3330	100
Dibenzofuran	100	3330	100
Di-n-butyl phthalate	100	3330	100
1,2-Dichlorobenzene	100	3330	100
1,3-Dichlorobenzene	100	3330	100
1,4-Dichlorobenzene	100	3330	100
3,3'-Dichlorobenzidine[1]	100	3330	100
2,4-Dichlorophenol	100	3330	100
Diethylphthalate	100	3330	100
2,4-Dimethylphenol	100	3330	100
Dimethylphthalate	100	3330	100
4,6-Dinitro-2-methylphenol	100	3330	100
2,4-Dinitrophenol	100	3330	100
2,4-Dinitrotoluene	100	3330	100
2,6-Dinitrotoluene	100	3330	100
Di-n-octylphthalate	100	3330	100

Table 5			
LCS and MS/SD Spiking Components and Concentrations in the Sample			
Compound	Aqueous (µg/L)	Solid (µg/kg)	Air (µg)
Fluoranthene	100	3330	100
Fluorene	100	3330	100
Hexachlorobenzene	100	3330	100
Hexachlorobutadiene	100	3330	100
Hexachlorocyclopentadiene	100	3330	100
Hexachloroethane	100	3330	100
Indeno(1,2,3-cd)pyrene	100	3330	100
Isophorone	100	3330	100
2-Methylnaphthalene	100	3330	100
2-Methylphenol	100	3330	100
4-Methylphenol	200	6670	200
Naphthalene	100	3330	100
2-Nitroaniline	100	3330	100
3-Nitroaniline[1]	100	3330	100
4-Nitroaniline	100	3330	100
Nitrobenzene	100	3330	100
2-Nitrophenol	100	3330	100
4-Nitrophenol	100	3330	100
n-Nitrosodimethylamine	100	3330	100
n-Nitrosodiphenylamine	100	3330	100
n-Nitrosodi-n-propylamine	100	3330	100
2,2'-Oxybis(1-chloropropane)	100	3330	100
Pentachlorophenol	100	3330	100
Phenanthrene	100	3330	100
Phenol	100	3330	100
Pyrene	100	3330	100
1,2,4-Trichlorobenzene	100	3330	100
2,4,5-Trichlorophenol	100	3330	100
2,4,6-Trichlorophenol	100	3330	100

[1] These are poor performers.

Table 6			
Surrogate Compounds and Spiking Levels			
Compound	Aqueous ug/L	Solid ug/kg	Air ug
2-Fluorobiphenyl	50	1660	50
2-Fluorophenol	75	2500	100
2,4,6-Tribromophenol	75	2500	100
Nitrobenzene-d5	50	1660	50
Phenol-d5	75	2500	100
Terphenyl-d14	50	1660	50
2-Chlorophenol-d4	75	2500	100
1,2-Dichlorobenzene-d4[1]	50	1660	50

[1] For Air work, this compound is spiked onto the media during preparation, before the air sample is collected.

Table 7			
Internal Standard Solution			
Component	**Concentration in Solution µg/mL**	**Concentration in Extract µg/mL**	**ng on-column (1µL injection)**
1,4-Dichlorobenzene-d4	2000	40	40
Naphthalene-d8	2000	40	40
Acenaphthene-d10	2000	40	40
Phenanthrene-d10	2000	40	40
Chrysene-d12	2000	40	40
Perylene-d12	2000	40	40

Table 8			
Dilution Guidance			
Dilution Factor[1]	µL of Sample Extract	µL IS Solution	µL DCM
1x (undiluted)	1000	20	NA
2x	500	10	500
5x	200	16	800
10x	100	18	900
20x	50	19	950

[1] For further dilutions, make serial dilutions. In general, add 1 µL IS solution for every 50 µL DCM added to the extract. In all cases, the µL IS solution to be added assumes that the source solution (undiluted extract, previous extract dilution, etc) was already spiked with IS solution.

Table 9
Calibration Levels, Primary Standard, µg/mL

Analyte	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Pyridine	5	10	20	50	80	120	160
n-Nitrosodimethylamine	5	10	20	50	80	120	160
Aniline	5	10	20	50	80	120	160
Phenol	5	10	20	50	80	120	160
bis(2-Chloroethyl)ether	5	10	20	50	80	120	160
2-Chlorophenol	5	10	20	50	80	120	160
1,3-Dichlorobenzene	5	10	20	50	80	120	160
1,4-Dichlorobenzene	5	10	20	50	80	120	160
Benzyl alcohol	5	10	20	50	80	120	160
1,2-Dichlorobenzene	5	10	20	50	80	120	160
2-Methylphenol	5	10	20	50	80	120	160
2,2'-Oxybis(1-chloropropane)[1]	5	10	20	50	80	120	160
4-Methylphenol	5	10	20	50	80	120	160
n-Nitroso-di-n-propylamine	5	10	20	50	80	120	160
Hexachloroethane	5	10	20	50	80	120	160
Nitrobenzene	5	10	20	50	80	120	160
Isophorone	5	10	20	50	80	120	160
2-Nitrophenol	5	10	20	50	80	120	160
2,4-Dimethylphenol	5	10	20	50	80	120	160
Benzoic acid	5	10	20	50	80	120	160
bis(2-chloroethoxy)methane	5	10	20	50	80	120	160
2,4-Dichlorophenol	5	10	20	50	80	120	160
1,2,4-Trichlorobenzene	5	10	20	50	80	120	160
Naphthalene	5	10	20	50	80	120	160
4-Chloroaniline	5	10	20	50	80	120	160
Hexachlorobutadiene	5	10	20	50	80	120	160
4-Chloro-3-methylphenol	5	10	20	50	80	120	160
2-Methylnaphthalene	5	10	20	50	80	120	160
Hexachlorocyclopentadiene	5	10	20	50	80	120	160
2,4,6-Trichlorophenol	5	10	20	50	80	120	160
2,4,5-Trichlorophenol	5	10	20	50	80	120	160
2-Chloronaphthalene	5	10	20	50	80	120	160
2-Nitroaniline	5	10	20	50	80	120	160
Dimethylphthalate	5	10	20	50	80	120	160
Acenaphthylene	5	10	20	50	80	120	160
3-Nitroaniline	5	10	20	50	80	120	160
Acenaphthene	5	10	20	50	80	120	160
2,4-Dinitrophenol	5	10	20	50	80	120	160
4-Nitrophenol	5	10	20	50	80	120	160
Dibenzofuran	5	10	20	50	80	120	160
2,4-Dinitrotoluene	5	10	20	50	80	120	160
2,6-Dinitrotoluene	5	10	20	50	80	120	160
Diethylphthalate	5	10	20	50	80	120	160
4-Chlorophenyl phenyl ether	5	10	20	50	80	120	160
Fluorene	5	10	20	50	80	120	160
4-Nitroaniline	5	10	20	50	80	120	160

Table 9
Calibration Levels, Primary Standard, µg/mL

Analyte	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
4,6-Dinitro-2-methylphenol	5	10	20	50	80	120	160
n-Nitrosodiphenylamine	5	10	20	50	80	120	160
Azobenzene[2]	5	10	20	50	80	120	160
4-Bromophenyl phenyl ether	5	10	20	50	80	120	160
Hexachlorobenzene	5	10	20	50	80	120	160
Pentachlorophenol	5	10	20	50	80	120	160
Phenanthrene	5	10	20	50	80	120	160
Anthracene	5	10	20	50	80	120	160
Carbazole	5	10	20	50	80	120	160
Di-n-butylphthalate	5	10	20	50	80	120	160
Fluoranthene	5	10	20	50	80	120	160
Benzidine	5	10	50	100	80	120	160
Pyrene	5	10	20	50	80	120	160
Butylbenzylphthalate	5	10	20	50	80	120	160
3,3'-Dichlorobenzidine	5	10	20	50	80	120	160
Benzo(a)anthracene	5	10	20	50	80	120	160
bis(2-Ethylhexyl)phthalate	5	10	20	50	80	120	160
Chrysene	5	10	20	50	80	120	160
Di-n-octylphthalate	5	10	20	50	80	120	160
Benzo(b)fluoranthene	5	10	20	50	80	120	160
Benzo(k)fluoranthene	5	10	20	50	80	120	160
Benzo(a)pyrene	5	10	20	50	80	120	160
Indeno(1,2,3-cd)pyrene	5	10	20	50	80	120	160
Dibenz(a,h)anthracene	5	10	20	50	80	120	160
Benzo(g,h,i)perylene	5	10	20	50	80	120	160

Calibration Levels, Surrogate Standard, µg/mL

Analyte	Level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
2-Fluorophenol	5	10	20	50	80	120	160
Phenol-d5	5	10	20	50	80	120	160
2-Chlorophenol-d4	5	10	20	50	80	120	160
1,2-Dichlorobenzene-d4	5	10	20	50	80	120	160
Nitrobenzene-d5	5	10	20	50	80	120	160
2-Fluorobiphenyl	5	10	20	50	80	120	160
2,4,6-Tribromophenol	5	10	20	50	80	120	160
Terphenyl-d14	5	10	20	50	80	120	160

[1] 2,2'oxybis(1-chloropropane) was formerly known as bis(2-chloroisopropyl)ether
[2]Azobenzene is formed by decomposition of 1,2-diphenlyhydrazine. If 1,2-diphenylhydrazine is requested, it will be analyzed as azobenzene.

Table 10
Calibration Levels, Appendix IX Standard, µg/mL

Semivolatiles	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
2-Picoline	10	20	50	80	120	160
n-Nitrosomethylethylamine	10	20	50	80	120	160
Methyl methanesulfonate	10	20	50	80	120	160
n-Nitrosodiethylamine	10	20	50	80	120	160
Ethyl methanesulfonate	10	20	50	80	120	160
Pentachloroethane	10-	20	50	80	120	160
Acetophenone	10	20	50	80	120	160
n-Nitrosopyrrolidine	10	20	50	80	120	160
n-Nitrosomorpholine	10	20	50	80	120	160
o-Toluidine	10-	20	50	80	120	160
3-Methylphenol	10	20	50	80	120	160
n-Nitrosopiperidine	10	20	50	80	120	160
o,o,o-Triethyl-Phosphorothioate	10-	20	50	80	120	160
a,a-Dimethylphenethylamine	10-	20	50	80	120	160
2,6-Dichlorophenol	10	20	50	80	120	160
Hexachloropropene	10-	20	50	80	120	160
p-Phenylenediamine	10-	20	50	80	120	160
n-Nitrosodi-n-butylamine	10	20	50	80	120	160
Safrole	10-	20	50	80	120	160
1,2,4,5-Tetrachlorobenzene	10	20	50	80	120	160
Isosafrole 1 + 2	10-	20	50	80	120	160
1,4-Dinitrobenzene	10	20	50	80	120	160
1,4-Naphthoquinone	10-	20	50	80	120	160
1,3-Dinitrobenzene	10	20	50	80	120	160
Pentachlorobenzene	10	20	50	80	120	160
1-Naphthylamine	10	20	50	80	120	160
2-Naphthylamine	10	20	50	80	120	160
2,3,4,6-Tetrachlorophenol	10-	20	50	80	120	160
5-Nitro-o-toluidine	10-	20	50	80	120	160
Thionazin	10-	20	50	80	120	160
1,3,5-Trinitrobenzene	10-	20	50	80	120	160
Sulfotepp	10-	20	50	80	120	160
Phorate	10-	20	50	80	120	160
Phenacetin	10-	20	50	80	120	160
Diallate 1 + 2	10-	20	50	80	120	160
Dimethoate	10	20	50	80	120	160
4-Aminobiphenyl	10-	20	50	80	120	160
Pentachloronitrobenzene	10-	20	50	80	120	160
Pronamide	10-	20	50	80	120	160
Disulfoton	10-	20	50	80	120	160
2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	10-	20	50	80	120	160
Methyl parathion	10-	20	50	80	120	160

Table 10
Calibration Levels, Appendix IX Standard, µg/mL

Semivolatiles	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
4-Nitroquinoline-1-oxide	10-	20	50	80	120	160
Parathion	10-	20	50	80	120	160
Isodrin	10	20	50	80	120	160
Kepone	10-	20	50	80	120	160
Famphur	10-	20	50	80	120	160
Methapyrilene	10-	20	50	80	120	160
Aramite 1 and 2	10-	20	50	80	120	160
p-(Dimethylamino)azobenzene	10-	20	50	80	120	160
p-Chlorobenzilate	10	20	50	80	120	160
3,3'-Dimethylbenzidine	10-	20	50	80	120	160
2-Acetylaminofluorene	10-	20	50	80	120	160
Dibenzo (a,j)acridine	10-	20	50	80	120	160
7,12-Dimethylbenz(a)anthracene	10-	20	50	80	120	160
3-Methylcholanthrene	10-	20	50	80	120	160

Title: Determination of Volatile Organics and Total Purgeable Petroleum Hydrocarbons by GC/MS [Methods 8260B, 8015B, AK 101 and NWTPH-Gx]

Approvals (Signature/Date):

David Allameh, Technical Manager — Date: 2/23/12	Joe Schairer, Health & Safety Manager / Coordinator — Date: 2/23/12
Douglas Weir, Quality Assurance Manager — Date: 02/23/12	Karla Buechler, Laboratory Director — Date: 2/29/12

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1. SCOPE AND APPLICATION

1.1. This method is applicable to the determination of Volatile Organic Compounds in waters, wastewater, soils, sludges and other solid matrices. Standard analytes and reporting limits are listed in Table 1. Total Purgeable Petroleum Hydrocarbons are listed in Appendix A.

1.2. This SOP is applicable to method 8260B, using prep methods 5030A, 5030B, 5035 and 5035A.

1.3. This method can be used to quantify most volatile organic compounds that have boiling points below 200ºC and are insoluble or slightly soluble in water. Volatile water soluble compounds can be included in this analytical technique; however, for more soluble compounds, quantitation limits are approximately ten times higher because of poor purging efficiency.

1.4. The method is based upon a purge and trap, gas chromatograph/mass spectrometric (GC/MS) procedure. The approximate working range is 0.5 to 80 ug/L for waters, 5 to 400 ug/kg for low-level soils, and 250 to 25,000 ug/kg for medium-level soils.

1.5. Method performance is monitored through the use of surrogate compounds, matrix spike/matrix spike duplicates, and laboratory control spike samples.

1.6. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Volatile compounds are introduced into the gas chromatograph by the purge and trap method. The components are separated via the chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information.

2.2. Aqueous samples are purged directly. Soil samples may be preserved with sodium bisulfate and purged directly, or preserved by extracting with methanol and diluting into reagent water.

2.3. In the purge and trap process, an inert gas is bubbled through the solution at ambient temperature or at 50°C (50°C required for low level soils) and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column (trap) is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. The gas chromatographic column is then heated to elute the components, which are detected with a mass spectrometer.

2.4. Qualitative identifications are confirmed by analyzing standards under the same conditions used for samples and comparing the resultant mass spectra and GC retention times. Each

identified component is quantified by relating the MS response for an appropriate selected ion produced by that compound to the MS response for another ion produced by an internal standard.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

3.3. %D (Percent Drift or Percent Difference)

%D is used to refer to both percent drift (Equation 4, Section 12.4.4) and percent difference (Equation 5, Section 12.4.5). The differences between the two calculations, and when they are each applied, are described in Section 12.

4. INTERFERENCES

4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. The use of ultra high purity gases, pre-purged purified reagent water, and approved lots of purge and trap grade methanol will greatly reduce introduction of contaminants. In extreme cases the purging vessels may be pre-purged to isolate the instrument from laboratory air contaminated by solvents used in other parts of the laboratory.

4.2. Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) into the sample through the septum seal during shipment and storage. A field blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination. Additionally, storage areas for volatile organic test requests are continuously monitored by analysis of a refrigerator holding blank (see WS-QA-002 for additional information on refrigerator blank analysis).

4.3. Matrix interferences may be caused by non-target contaminants that are coextracted from the sample. The extent of matrix interferences will vary considerably from source to source depending upon the nature and diversity of the site being sampled.

4.4. Cross-contamination can occur whenever high-level and low-level samples are analyzed sequentially or in the same purge position on an autosampler. Whenever an unusually concentrated sample is analyzed, it should be followed by one or more blanks to check for cross-contamination. The purge and trap system may require extensive bake-out and cleaning after a high-level sample.

4.5. Some samples may foam when purged due to surfactants present in the sample. When this kind of sample is encountered the sample is diluted until foaming is minimized and sample analysis can proceed.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Analysts must wear approved cut resistant gloves when opening or closing VOA vials. These can be either Ansell HyFlex NBR, Kevlar, or MAPA Blue-Grip latex. Chemical protective gloves must be worn under or over these gloves, as needed.

5.1.2. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex, nitrile and vinyl gloves all provide adequate protection against the methanol used in this method.

5.1.3. Exposure to chemicals must be maintained as low as reasonably achievable; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.4. Laboratory procedures such as repetitive use of pipets, repetitive transferring of samples or extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.5. Purge vessels on purge-and-trap instruments can be pressurized by the time analysis is completed. Vent the pressure prior to removal of these vessels to prevent the contents from spraying out.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the**

method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Sodium Bisulfate	Corrosive	None Listed	Contact may cause skin/eye burns. Inhalation can cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing and shortness of breath. Causes chemical burns to the respiratory tract. May cause fatal spasms, inflammation or pulmonary/respiratory edema.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Gas tight micro syringes: 10 uL and larger.

6.2. Gas tight syringe: 5 to 25 mL glass with Luerlock tip, if applicable to the purging device.

6.3. Balance: Analytical, capable of accurately weighing 0.0001 g, and a top-loading balance capable of weighing 0.01 g

6.4. Glassware:

6.4.1. Vials: 20 mL with screw caps and Teflon liners.

6.4.2. Vials: 40 mL with screw caps and Teflon liners.

6.4.3. Vials: 40 mL with screw caps, Teflon liners, magnetic stirbars. Vials may also contain 5 mL of sodium bisulfate preservative solution.

6.4.4. Volumetric flasks: 10 mL, 50 mL and 100 mL, class A with ground-glass stoppers.

6.5. Spatula: Stainless steel.

6.6. Disposable pipettes: Pasteur.

6.7. pH paper: Wide range.

6.8. Purge and Trap Device: The purge and trap device consists of the sample purger, the trap, and the desorber.

6.8.1. Autosampler: The closed loop autosampler must accommodate 40 ml VOC vials with low bleed Teflon septa. For soil analysis, the unit must heat the VOC vial to 50ºC and actuate a magnetic stir bar during sample purging in the vial. For water analysis, the unit must be able to deliver a measured amount of sample from a sealed VOC vial into the purging cell.

6.8.2. Sample Purger: The purge gas must pass through the water column as finely divided bubbles, each with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. Alternative sample purge devices may be used provided equivalent performance is demonstrated. Low level soils are purged directly from a VOA vial.

6.8.3. Trap: A variety of traps may be used, depending on the target analytes required. For most purposes, the Vocarb #10 trap (Tenax / Silica gel / Carbon molecular sieve) is suitable. Other traps, such as Vocarb 4000, or Tenax / Silica gel / Charcoal may be used if the Quality Control criteria are met.

6.8.4. Desorber: The desorber should be capable of rapidly heating the trap to 180ºC. Many such devices are commercially available.

6.9. Gas Chromatograph/Mass Spectrometer System:

6.9.1. Gas Chromatograph: The gas chromatograph (GC) system must be capable of temperature programming.

6.9.2. Gas Chromatographic Columns: The recommended column is a DB-624 20m x 0.18 mm ID, 1 µm film thickness.

6.9.3. Mass Spectrometer: The mass spectrometer must be capable of scanning 35-300 AMU every two seconds or less, using 70 volts electron energy in the electron impact mode and capable of producing a mass spectrum that meets the required criteria when 50 ng of 4-Bromofluorobenzene (BFB) are injected onto the gas chromatograph column inlet.

6.9.4. GC/MS interface: In general, glass jet separators are used, but any interface (including direct introduction to the mass spectrometer) that achieves all acceptance criteria may be used.

6.9.5. Data System: A computer system that allows the continuous acquisition and storage on machine readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that allows searching any GC/MS data file for ions of a specified mass and plotting

such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundances in any EICP between the specified time or scan-number limits. Also, for the non-target compounds, software must be available that allows for the comparison of sample spectra against reference library spectra. The most recent release of the NIST/EPA mass spectral library should be used as the reference library. The computer system must also be capable of backing up data for long-term off-line storage.

7. REAGENTS AND STANDARDS

7.1. Organic Free Water

Organic free water is defined as water in which an interferent is not observed at the reporting limit of the compounds of interest. Organic free water is generated by continuous sparging of deionized or distilled water with helium or nitrogen.

7.2. Gases for GC operation (i.e., carrier): helium, nitrogen

7.3. Sodium bisulfate solution: already present in pre-prepared VOA vials.

7.4. Methanol -- Purge and Trap Grade

7.5. Calibration Standard

7.5.1. Stock Solutions:

Stock solutions may be purchased as certified solutions from commercial sources or prepared from pure standard materials as appropriate. These standards are prepared in methanol and stored in Teflon-sealed screw-cap bottles with minimal headspace at -10° to -20°C. Stock standards for non-gases must be replaced at least every 6 months (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Stocks may be replaced sooner if comparison with check standards prepared from an independent source indicates a problem. Stock standards for the gases (bromomethane, chloromethane, chloroethane, vinyl chloride, bromoethane, trichlorofluoromethane, dichlorodifluoromethane) must be replaced every 2 months (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Once opened, gas stock standards are aliquoted to vials, each stored with minimum headspace for up to 2 months. Each vial is used for no more than one week.

7.5.2. Working standards:

A working solution containing the compounds of interest is prepared from the stock solution(s) in methanol. These standards are stored in the freezer or as recommended by the manufacturer. Working standards are monitored by

comparison to the initial calibration curve. If any of the compounds drift in response from the initial calibration by more than 20% then fresh standards may need to be prepared.

7.5.3. Calibration standards are prepared in reagent water using the secondary dilution standards. These aqueous standards must be prepared daily. These standards are prepared in 50 or 100 mL volumetric flasks according to the recipes in the table section of this SOP.

7.5.4. If stock or secondary dilution standards are purchased in sealed ampules they may be used up to the manufacturers expiration date or within 6 months of opening, whichever is sooner.

7.5.5. Each multipoint calibration curve must be compared against a second source standard that is independent of the solution used for preparing the curve. This practice is to ensure that no adverse drift in response is occurring.

7.6. Internal Standards: Internal standards are added to all samples, standards, and blank analyses. Refer to Table 10 for internal standard components.

7.7. Surrogate Standards: Refer to Table 11 for surrogate standard components and spiking levels.

7.8. Laboratory Control Sample and Matrix Spiking Solutions: Refer to Table 12 for LCS/MS/MSD components and spiking levels.

7.9. Tuning Standard: A standard is made up that will deliver 50 ng on column upon injection. A recommended concentration is 25 ng/uL of 4-Bromofluorobenzene in methanol.

7.10. Initial Calibration Verification (ICV): A standard solution containing the analytes present in the calibration standards, but prepared from a source separate from the calibration standards. The LCS spiking standard may be used as an ICV.

7.11. Calibration standards are prepared by injecting a measured volume of the stock standard into a syringe containing the appropriate volume of organic free water. The calibration standard is then loaded into the purge device.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Water samples are normally preserved in the field at pH < 2 with 1:1 hydrochloric acid.

8.1.1. The maximum holding time is 14 days from sampling until the sample is analyzed (samples that are found to be unpreserved are still analyzed within the 14 day holding time per SW-846, however, the lack of preservation should be addressed in the case narrative). If samples are known to be received without preservation, the holding time is 7 days from sampling to analysis based on guidance from method 624. Samples that require the analysis of 2-chloroethylvinylether must be

sampled unpreserved. The lab must give prior approval to accepting samples for 2-chloroethylvinylether.

8.1.2. All samples are stored in glass containers with Teflon lined septa at 4 ± 2°C, with minimal headspace.

8.2. Solid samples may be received in several ways, which affects the holding time. All solid samples are stored at 4 ± 2°C until analysis, unless otherwise noted.

8.2.1. Grab samples: The solid sample used for volatiles analysis is an aliquot taken from the sample container. The container is typically an 8 or 16 ounce jar, or a core tube. These samples have a holding time of 14 days from date of sampling to date of analysis. If a medium-level analysis is required, the holding time does not change.

8.2.2. EnCore samples: The samples are shipped to the laboratory in EnCore sampling sleeves. The laboratory must preserve these within 48 hours of sampling. In general, 3 sleeves are submitted for each sample. Two of these are preserved with sodium bisulfate / H_2O solution, and the third is preserved with methanol, with a holding time of 14 days from sampling to analysis. If effervescence occurs, one of the sodium bisulfate fractions is preserved with water and frozen at –7°C until analysis. In this case, samples must be analyzed within 14 days of sampling. Alternatively, samples may be extruded into an empty sealed VOA vial and frozen within 48 hours of sampling, then analyzed within 14 days of sampling. Certain programs or states, such as Hawaii, may set a 7 day hold time for frozen samples.

8.2.3. Field preserved: Solid samples are taken and preserved in the field with either sodium bisulfate solution, methanol, or frozen in a VOA vial. Samples frozen in encores must be analyzed or transferred to a sealed VOA vial within 48 hours of sampling.

8.3. Methanolic solid extracts may be aliquotted into 2 - 5 mL glass vials or maintained in original 20 mL VOA vials with Teflon lined caps and stored at 4 ± 2°C. The extracts are stored with minimal headspace. These extracts must be analyzed within 14 days of collection.

8.4. The maximum holding time for all volatile analyses is 14 days from sample collection.

8.5. At specific client request, unpreserved soils packed into glass jars or brass tubes may be accepted and subsampled in the lab. This is the old procedure based on method 5030A. It is no longer included in SW-846 and is likely to generate results that are biased low.

8.6. Holding blanks are prepared, stored, and analyzed in accordance with SOP WS-QA-0002, “Procedure for the Set-Up, Maintenance, and Analysis of Holding Blanks for Volatile Refrigerators”.

9. QUALITY CONTROL

9.1. Batch

The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same time period. Using this logic, each BFB analysis will normally start a new batch. Batches for laboratory preserved medium level soils are defined at the sample preparation stage and may be analyzed on multiple instruments over multiple days, although reasonable effort should be made to keep the samples together. Batches for field-preserved medium level solids are defined at the initial analysis, and may be analyzed on multiple instruments over multiple days, although reasonable effort should be made to keep the samples together.

9.1.1.

The Quality Control batch must contain a matrix spike/spike duplicate (MS/MSD), a Laboratory Control Sample (LCS), and a method blank. In some cases, a LCS/LCSD may be used if there is insufficient sample volume for a MS/MSD if batch precision is required by the client or program. A NCM (Non Conformance Memo) must be generated in this case. Refer to the QC Program document (WS-PQA-003) for further details of the batch definition.

9.2. Method Blanks

For each batch of samples, analyze a method blank. The method blank is analyzed after the calibration standards, normally before any samples. For low-level volatiles, the method blank consists of reagent water. For medium-level volatiles, the method blank consists of methanol. Surrogates are added and the method blank is carried through the entire analytical procedure. The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, see below) or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

- Corrective action is not required for levels below the reporting limit (i.e., “J” values).
- If the analyte is a common laboratory contaminant (methylene chloride, acetone, 2-butanone) the data may be reported with qualifiers if the concentration of the analyte is less than five times the reporting limit. Such action must be taken in consultation with the QA department and the client.
- Reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations less than 10 times the method blank are determined in the samples.
- If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers.
- The method blank must have acceptable surrogate recoveries. If surrogate recoveries are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the analysis is free of contamination. If surrogate recoveries are low, and there are reportable analytes in the associated

samples, re-extraction of the blank and affected samples will normally be required. Consultation with the QA department and the client should take place.

- The DOD QSM criteria for method blanks is no analytes detected greater than ½ the reporting limit (RL). For common laboratory contaminants, it is no analytes detected greater than the RL.

9.2.1. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all associated samples are flagged with a "B," and appropriate comments may be made in a narrative to provide further documentation.

9.2.2. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.3. Laboratory Control Samples (LCS)

For each batch of samples, analyze an LCS. The LCS is analyzed after the calibration standard(s), and normally before any samples. The LCS contains a representative subset of the analytes of interest (see Table 12), and must contain the same analytes as the matrix spike. Upon client request, additional analytes may be added to the LCS. If any control analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch. The analyst should monitor the system if non-control analytes are outside of established control limits, and perform corrective action as necessary to prevent re-occurring failures.

- If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. (An example of acceptable reasons for not reanalyzing might be that sample surrogate recoveries are good and recoveries are high, and samples were ND for these analytes.)
- If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.

9.3.1. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.4. Matrix Spikes

For each QC batch, analyze a matrix spike and matrix spike duplicate (MS/MSD). Spiking compounds and levels are given in Table 12. Compare the percent recovery and relative percent difference (RPD) to the historically generated limits.

- If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in the LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented using a non-conformance memo.

- If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the laboratory is out of control and corrective action must be taken. Corrective action will normally include reanalysis of the batch.
- If a MS/MSD is not possible due to limited sample volume, then a LCS duplicate may be analyzed if batch precision is required by the client or program. RPD of the LCS and LCSD are compared to the matrix spike limits.
- The MS/MSD must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out, or the spiked analytes will be over the calibration range.

9.4.1. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.5. Surrogates

Every sample, blank, and QC sample is spiked with surrogates. Surrogate recoveries in samples, blanks, and QC samples must be assessed to ensure that recoveries are within established limits. The compounds included in the surrogate spiking solutions are listed in Table 11. If any surrogates are outside limits, the following corrective actions must take place (except for dilutions of extracted samples):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze if either of the above checks reveal a problem.
- Re-prepare and reanalyze the sample or flag the data if neither of the above resolves the problem.

It is only necessary to re-prepare/reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that there is a problem with either of the two analyses other than a matrix effect.

9.5.1. If the surrogates are out of control for the sample, matrix spike, and matrix spike duplicate, then matrix effect has been demonstrated for that sample and re-preparation is not necessary. If the sample is out of control and the MS and/or MSD is in control, then reanalysis or flagging of the data is required.

9.5.2. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.6. Internal Standards

Internal standards are components similar in nature to the analytes of interest. These are added to every sample (including QC aliquots) and standard analyzed. The purpose is to enable calculations based on internal standard methodology. Internal standard recoveries are monitored to verify that instrument performance is acceptable. Criteria for standards are delineated in Section 10. If the internal standard data indicate instrument failure, the

samples may require reanalysis. If not, the impact on sample data is evaluated and the data is flagged appropriately.

9.6.1. Any samples that do not meet the internal standard criteria for the continuing calibration (Section 10.7) must be evaluated for validity. If the change in internal standard response is a matrix effect confined to an individual sample, reanalysis is not necessary. If the change in internal standard response is due to instrumental problems, all affected samples must be reanalyzed after the problem is corrected.

9.7. Control Limits

In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). These limits must be determined at least annually. The recovery limits are mean recovery ± 3 standard deviations for surrogates, matrix spikes and LCS. Precision limits for matrix spikes / matrix spike duplicates are 0 to mean relative percent difference + 3 standard deviations.

9.7.1. All surrogate, LCS, and MS recoveries (except for dilutions) must be entered into QuantIMS (when available) or other database so that accurate historical control limits can be generated. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.7.2. Refer to the QC Program document (WS-PQA-003) for further details of the corrective action.

9.8. Nonconformance and Corrective Action

Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the facility QA Manager.

9.9. Quality Assurance Summaries

Some clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries should be developed to address these requirements.

9.10. TestAmerica West Sacramento QC Program

Further details of QC and corrective action guidelines are presented in the QC Program document (WS-PQA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION

10.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 “Calibration Curves (General)”.

10.2. Summary

Prior to the analysis of samples and blanks, each GC/MS system must be tuned and calibrated. Hardware tuning is checked through the analysis of the 4-Bromofluorobenzene (BFB) to establish that a given GC/MS system meets the standard mass spectral abundance criteria. The GC/MS system must be calibrated initially at a minimum of five concentrations (analyzed under the same BFB tune), to determine the linearity of the response utilizing target calibration standards. Once the system has been calibrated, the calibration must be verified each twelve hour time period for each GC/MS system. The use of separate calibrations is required for water/medium level soil and low soil matrices.

10.3. Recommended Instrument Conditions

More details of recommended instrument conditions may be found in Table 15.

Gas chromatograph suggested temperature programs	
BFB Analysis	85°C (no hold) 20°C/minute to 160°C (hold 2.0 min) 50°C/minute to 200°C (hold 1.2 min)
Sample Analysis	35°C (hold 2 min) 15°C/minute to 200°C (hold 3.0 min)

10.4. Instrument Tuning

Each GC/MS system must be hardware-tuned to meet the abundance criteria listed in Table 13 for a 50 ng injection of BFB (1 uL of a 50 ng/uL standard). Analysis must not begin until these criteria are met. These criteria must be met for each twelve-hour time period. The twelve-hour time period begins at the moment of injection of BFB.

10.4.1. To evaluate the BFB tune, verify that the software averaged three scans, at the apex, 1 scan before the apex, and one scan after the apex. Alternatively, the scan at the apex may be evaluated.

10.4.2. Background subtraction should be employed. The scan used for background subtraction must be before the elution of BFB, but no earlier than 20 scans before the elution of BFB, and may not include part of the peak.

10.5. Initial Calibration

A series of at least five initial calibration standards is prepared and analyzed for the target compounds and each surrogate compound (this is referred to as a “five-point calibration” later in this SOP). Typical calibration levels for aqueous samples are: 0.25, 0.5, 1, 4, 20, 40, 60, and 80 µg/L. Some analytes are prepared at higher concentrations due to poor purge performance. Tables 2 and 3 list the calibration levels for each analyte in solid and aqueous samples. Other calibration levels and purge volumes may be used depending on the capabilities of the specific instrument. However, the same purge volume must be used for calibration and sample analysis, and the low level standard must be at or below the reporting limit.

10.5.1. It may be necessary to analyze more than one set of calibration standards to encompass all of the analytes required for some tests. For example, the Appendix

IX list requires the "normal 8260" standard and the Appendix IX standard. If acceptable analytical performance can be obtained, the primary and Appendix IX standards may be analyzed together.

10.5.2. Internal standard calibration is used. The internal standards are listed in Table 10. Target compounds should reference the nearest internal standard. Each calibration standard is analyzed and the relative response factor (RRF) for each compound is calculated using the area response of the characteristic ions against the concentration for each compound and internal standard. See Equation 1, Section 12, for calculation of relative response factor.

10.5.3. A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include new (uncalibrated) columns. A new calibration is not required after performing column maintenance, replacing the septum or syringe, or performing other minor maintenance.

10.5.4. With the exception of instances detailed in Policy CA-Q-S-005, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in the calibration curve. Quadratic (second order) calibrations require at least six points.

10.6. Evaluating the Initial Calibration

10.6.1. Calculate the average relative response factor for each compound. Verify that the System Performance Check Compounds (SPCC) below meet their minimum average relative response factor:

SPCC Compounds and Minimum Response Factors			
Compound	**Min. RRF**	**Compound**	**Min. RRF**
Chloromethane	0.100	1,1,2,2-Tetrachloroethane	0.300
1,1-Dichloroethane	0.100	Chlorobenzene	0.300
Bromoform	0.100		

10.6.1.1. If the average RRF for any of the SPCC compounds is less than the minimum specified, the calibration is not valid. The initial calibration must be repeated before analysis may continue. Instrument maintenance may be required.

10.6.2. Calculate the %RSD for each compound. Evaluate the %RSDs of the Calibration Check Compounds (CCC) listed below, which must be less than 30%.

CCC Compounds	
Vinyl Chloride	1,2-Dichloropropane
1,1-Dichloroethene	Toluene

Chloroform	Ethylbenzene

10.6.2.1. If the %RSD for any CCC compound is greater than 30%, the calibration is not valid. The initial calibration must be repeated before analysis may continue. Instrument maintenance may be required.

10.6.2.2. If none of the CCCs are required analytes, project specific calibration specifications may be negotiated with the client.

10.6.3. Evaluate the %RSD of each analyte.

10.6.3.1. If the %RSD is ≤ 15% for a compound, the average relative response factor is used to quantitate that compound.

10.6.3.2. If the %RSD is > 15% for a compound, attempt a linear curve fit. Linear curve fits must have a correlation coefficient (r) of ≥ 0.995, or a coefficient of determination (r^2) of ≥ 0.990. In addition, the y intercept (listed as "b" on the Target ICAL summary page) should be within +(RL/ISTD) to –1/2(RL/ISTD). If the intercept exceeds this criterion, false positives or negatives could result. If the intercept exceeds +1/2(RL/ISTD), then J values should be evaluated for possible false positives. If the RL is elevated for client or project requirements, use the default RL in the calculation

Note: The RL value must be in terms of the amount "on-column" on the instrument.

10.6.3.3. If the linear fit does not meet criteria, a quadratic curve fit may be attempted. The coefficient of determination (r^2) must be ≥ 0.990 and the y intercept (listed as "b" on the Target ICAL summary page) should be within +(RL/ISTD) to –1/2(RL/ISTD). If the intercept exceeds this criterion, false positives or negatives could result. If the intercept exceeds +1/2(RL/ISTD), then J values should be evaluated for possible false positives. If the RL is elevated for client or project requirements, use the default RL in the calculation

Note: The RL value must be in terms of the amount "on-column" on the instrument.

10.6.3.4. If neither curve fit meets criteria, the "grand average" approach may be employed. Average the %RSDs of all compounds in the calibration. If this value is ≤ 15%, then all analytes may use average response factor for calibration. If this criterion is not met, the calibration must be repeated before analysis may continue. If the grand average approach is used, the client must be notified via a non-conformance memo of any analytes in the calibration curve that exceed the 15% criteria for which there are either reportable hits or QC failures. No analytes may exceed 40%D.

10.6.4. Weighting of data points

In a linear or quadratic calibration fit, the points at the lower end of the calibration curve have less weight in determining the curve generated than points at the high concentration end of the curve. However, in environmental analysis, accuracy at the low end of the curve is very important. For this reason it is preferable to increase the weighting of the lower concentration points. $1/Concentration^2$ weighting (often called $1/X^2$ weighting) will improve accuracy at the low end of the curve and should be used if the data system has this capability.

10.6.5. Internal Standards

Evaluate the IS response for each calibration level against the IS response in the CCV-level calibration standard. If the internal standard response in a given calibration level is more than 200% or less than 50% of the response in the mid-level of the initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of the initial calibration performed while the system was malfunctioning is required.

10.6.6. Initial Calibration Verification (ICV) – When available, a second source standard is analyzed with the initial calibration curve. Each compound of the ICV must be within ≤ 25%D, with the following exceptions:

Classification	Criteria
Gases:	Up to three gases at ≤30%D (chloroethane, bromomethane, dichlorodifluoromethane)
Ketones:	Up to two ketones at ≤ 30%D (acetone, 2-butanone, 4-methyl-2-pentanone, 2-hexanone)
Poor purgers/Poor Responders:	Carbon disulfide ≤ 40%D 1,4-dioxane ≤ 50%D 2-chloroethylvinyl ether ≤ 35%D Vinyl acetate ≤ 40 %D
Appendix IX: (see Table 8)	≤ 50%D

Check QAPP requirements, or ensure that the client is aware of these exceptions.

Corrective actions for the ICV include:

- Rerun the ICV

- Remake or acquire a new ICV
- Evaluate the instrument conditions
- Evaluate the Initial Calibration Standards

10.7. If time remains in the 12-hour period initiated by the BFB injection before the initial calibration, samples may be analyzed. Otherwise, proceed to continuing calibration.

10.8. Continuing Calibration: The initial calibration must be verified every twelve hours.

10.8.1. Continuing calibration begins with analysis of BFB as described in Section 10.3. If the system tune is acceptable, the continuing calibration standard(s) are analyzed. The level 5 calibration standard is generally used as the continuing calibration.

10.8.2. The RF data from the standards are compared with the average RF from the initial five-point calibration to determine the percent drift of the CCC compounds. The calculation is given in equation 4, Section 12.3.4. In addition, the % drift of all non CCC analytes must be ≤ 40% (not to exceed 25% for AFCEE or DOD, 20% for DOD 4.1, or predetermined exceptions). Non-CCC analytes above 20%D are tracked for possible future corrective action.

10.8.3. The % drift of the CCCs **must** be ≤ 20% for the continuing calibration to be valid. The SPCCs are also monitored. The SPCCs must meet the criteria described in Section 10.5.1.

10.8.3.1. If the CCCs are not included in the list of compounds for a project, and therefore not included in the calibration standards, than all compounds **must** meet the 20% difference of drift criterion.

10.8.4. If the CCCs or the SPCCs do not meet the criteria in Section 10.5.3, the system must be evaluated and corrective action must be taken. The BFB tune and continuing calibration must be acceptable before analysis begins.

10.8.5. If the retention time for any internal standard in the continuing calibration changes by more than 0.5 minutes from the mid-level initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

10.8.6. If the internal standard response in the continuing calibration is more than 200% or less than 50% of the response in the mid-level of the initial calibration standards, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

10.8.7. Once the above criteria have been met, sample analysis may begin. Initial calibration average RFs (or the calibration curve) will be used for sample

quantitation, not the continuing calibration RFs. Analysis may proceed until 12 hours from the injection of the BFB have passed. (A sample *desorbed* less than or equal to 12 hours after the BFB is acceptable.)

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Preliminary Evaluation

11.2.1. Where possible, samples are screened by GC or GC/MS off-tune analysis to determine the correct aliquot for analysis. Alternatively, an appropriate aliquot can be determined from sample histories.

11.2.2. Dilutions should be done just prior to the GC/MS analysis of the sample, as described in Section 11.12.

11.3. Sample Analysis

11.3.1. All analytical conditions for samples must be the same as for the initial and continuing calibration standards (including purge time and flow, desorb time and temperature, column temperatures, multiplier setting etc.).

11.3.2. All samples must be analyzed as part of a batch. The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same time period. The batch also must contain an MS/MSD, an LCS, and a method blank.

11.3.2.1. The 12-hour tune period defines the batch. If any re-tuning of the instrument is necessary, or if a period of greater than 12 hours from the preceding BFB tune has passed, a new batch must be started. For medium level soils the batch is defined at the sample preparation/preservation stage.

11.3.2.2. Laboratory generated QC samples (Method Blank, LCS, MS/MSD) do not count towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.

11.3.2.3. It is not necessary to reanalyze batch QC with reanalysis of samples. However, any reruns must be as part of a valid batch.

11.3.2.4. Regardless of the matrix being evaluated, the analytical sequence starts with an acceptable BFB tuning check, followed by an ICAL of at least five points, or a CCV that meets %D criteria from an existing ICAL, as well as the CCC and SPCC criteria. Analysis continues until 12 hours from the tune analysis has passed.

11.4. Aqueous Sample Analysis

Internal standard and surrogate solutions are added at the rate of 1uL per sample to each sample prior to purging. Refer to Tables 10 and 11 for composition of these solutions.

11.4.1. All samples and standard solutions must be at ambient temperature before analysis.

11.4.2. Begin the analytical sequence as described in Section 11.3, above.

11.4.3. Prepare and analyze an LCS (and LCSD, if required). Partially fill a 50 mL volumetric flask with reagent water, and spike as noted below. Add reagent water to the line, stopper the flask, and gently invert 3 times to mix. Fill one 40 mL VOA vial from the volumetric flask, and cap it. Place the vial on the instrument. The "normal 8260" LCS is required with all sample analyses; the "AP9" LCS is performed only when requested by the client, or on an annual basis.

Aqueous LCS Spiking

Solution	Final Volume (mL)	Volume Spiked (uL)	
		Normal 8260 LCS	AP9 LCS
TCL AB (200 ug/mL)	50	5	--
Vinyl Acetate (200 ug/mL)	50	5	--
Odd (200 - 5000 ug/mL)	50	5	--
AP9A (200 - 5000 ug/mL)	50	--	5
AP9B (200 ug/mL)	50	--	5
Acrolein (2000 ug/mL)	50	--	5

Composition of the solutions above is defined in the Table Section of this SOP.

11.4.4. Follow the LCS with clean-out blanks, as needed.

11.4.5. Prepare and analyze a method blank. Fill a VOA vial with reagent water, and cap. Place the vial on the instrument.

11.4.6. Once LCS and MB have been evaluated, up to 20 field samples may be added to the instrument. If matrix spikes are required, the matrix spike solutions must be added to the vial prior to analysis. Spike as indicated below through the septum of the sample. Invert to mix, and place on the instrument.

Aqueous Sample Spiking in a 43 mL VOA vial		
Spiking Standard	Volume Spiked (uL)	
	Normal 8260 MS/SD	AP9 MS/SD
TCL AB (200 ug/mL)	4.3	--
Vinyl Acetate (200 ug/mL)	4.3	--
Odd (200 - 5000 ug/mL)	4.3	--
AP9A (200 - 5000 ug/mL)	--	4.3
AP9B (200 ug/mL)	--	4.3
Acrolein (2000 ug/mL)	--	4.3

Composition of the solutions above is defined in the Table Section of this SOP.

Note: *Samples with high amounts of sediment present in the vial may not be suitable for analysis on this instrumentation.*

11.4.7. Samples are purged, desorbed and analyzed under the same conditions as standards and QC, according to Table 15.

11.4.8. Sample remaining in the vial after sampling with one of these mechanisms is no longer valid for further analysis. A fresh VOA vial must be used for further sample analysis.

11.4.9. Check and record the pH of the sample remaining in the VOA vial after analysis is completed.

11.5. Preserving solid samples (in EnCore samplers) for low level analysis (laboratory preservation with sodium bisulfate). (Method 5035 and 5035A)

Note: The laboratory can accommodate only the 5 g samplers for low-level analysis.

11.5.1. Use pre-prepared VOA vials containing a magnetic stir bar and 5.0 mL of sodium bisulfate solution.

11.5.2. Attach a label. The label must not cover the neck of the vial or the autosampler will malfunction.

11.5.3. Tare the vial.

11.5.4. Extrude the soil sample from the EnCore sampler into the prepared VOA vial. Weigh the vial to the nearest 0.01 g to obtain the weight of soil and note in the sample preservation log. Proceed to Section 11.7.

11.5.5. If the sample will not be analyzed immediately, store at 4 ± 2°C until analysis. Proceed to Section 11.7.

Note: Soils containing carbonates may effervesce when added to the sodium bisulfate solution. If this is the case at a specific site, add 5 mL of water instead, and freeze at ≤-10°C until analysis. Proceed to Section 11.7.

11.6. When preparing solid samples sub-sampled from grab samples for low level analysis (method 5030A), refer to SOP WS-QA-0018 for sub-sampling procedures.

11.6.1. Prepare VOA vials by adding a magnetic stir bar.

11.6.2. Tare the vial, and sub-sample approximately 5 g soil into the vial. Record the mass to the nearest 0.01g.

Note: Less than 5 g soil may be used (to a minimum of 1 g) if slight sample dilution is required. See Section 11.12.

11.6.3. Add 5 mL of reagent water to the sample, seal the vial and label.

11.6.4. Proceed immediately to Section 11.7 for analysis.

11.7. Low-Level Solids Analysis

Internal standard and surrogate solutions are added at the rate of 1uL per sample, in 5 mL reagent water to each sample prior to purging. Refer to Tables 10 and 11 for composition of these solutions, and final sample concentrations.

11.7.1. This method is based on purging a heated sediment/soil sample mixed with organic free water containing the surrogate and, if applicable, matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples (e.g., heated). The calibration curve is also heated during analysis. Purge temperature is 50°C. Instrument conditions are in table 15.

11.7.2. Begin the analytical sequence as described in Section 11.4, above.

11.7.3. If some of the samples to be analyzed in the batch are preserved with sodium bisulfate are to be analyzed in the batch, use a pre-preserved vial for the method blank. Otherwise, prepare a method blank by adding 5 mL of reagent water to a VOA vial with stir bar. Seal and label the vial.

11.7.4. Prepare an LCS (and LCSD if required) by spiking 5 mL of reagent water with 2.5 uL of each matrix spiking solution. Place in a 40 mL VOA vial with stir-bar, seal and label the vial(s).

Low-level Solid Sample Spiking (5 gram)		
Spiking Standard	Volume Spiked (uL)	
	Normal 8260 MS/SD	AP9 MS/SD
TCL AB (200 ug/mL)	2.5	--
Vinyl Acetate (200 ug/mL)	2.5	--
Odd (200 - 5000 ug/mL)	2.5	--
AP9A (200 - 5000 ug/mL)	--	2.5
AP9B (200 ug/mL)	--	2.5
Acrolein (2000 ug/mL)	--	2.5

11.7.5. For matrix spike aliquots, spike as outlined in Section 11.7.4 above.

11.7.6. Soil samples that have low surrogate recovery when analyzed should be reanalyzed once to confirm matrix effect.

11.8. Preparing solid samples field preserved with methanol (without surrogate):

11.8.1. When the samples are returned to the lab, obtain the weight of the soil added to the vial and note in the preservation log.

11.8.2. Proceed to Section 11.9.3, below.

11.9. Preparing solid samples (in EnCore samplers) for medium level analysis (laboratory preservation with methanol). (Methods 5035 and 5035A)

11.9.1. Tare a VOA vial containing 5 mL methanol.

11.9.2. Extrude the (nominal) 5 g sample into the tared vial. Weigh the vial plus soil, and record the sample weight to nearest 0.01g in the preservation logbook.

11.9.3. Spike each sample as noted below. All values are assuming a nominal 5g sample. The addition of spike introduces a slight error (0.4%) into the calculations, which can be neglected.

Methanol Extracted Solid Sample Spiking			
Spiking Standard	Volume Spiked (uL) onto 5 g soil		
	Normal Sample	Normal 8260 LCS/LCSD/MS/SD	AP9 LCS/LCSD/MS/SD
Surrogate (100 ug/mL)	8µL	50µL	50
TCL A (200 ug/mL)	--	50µL	--
TCL B (200 ug/mL)	--	50µL	
Vinyl Acetate (200 ug/mL)	--	50µL	--
Odd (200 - 5000 ug/mL)	--	50µL	--
AP9A (200 - 5000 ug/mL)	--	--	50
AP9B (200 ug/mL)	--	--	50
Acrolein (2000 ug/mL)	--	--	25

11.9.4. Prepare an LCS for each batch by adding the correct amount of matrix spiking and surrogate spiking solutions to 5 mL methanol.

11.9.5. Prepare a method blank for each batch by adding the correct amount of surrogate solution to 5 mL of methanol in a VOA vial.

11.9.6. Shake the samples for two minutes to distribute the methanol throughout the soil.

11.9.7. Best results are obtained by allowing the samples to equilibrate with the methanol for at least 48 hours before continuing with the analysis. Since this is not always possible, be certain to note the preparation time as well as date in the preservation logbook.

11.9.8. Allow to settle. The extract aliquot is maintained in its original 20 mL VOA vial at 4 ± 2°C until analysis. Proceed to Section 11.11 for analysis.

11.10. Methanol Extract Soil Analysis

For field preserved samples, internal standard and surrogate are added by the autosampler prior to purging, as in aqueous analysis (Section 11.4, above). For laboratory preserved samples, surrogate is added at the time of preservation, and the internal standard is added when the methanol solution is added to the VOA vial.

11.10.1. Methanol extracts are analyzed under the same instrumental conditions as aqueous samples, i.e., purging at ambient temperatures.

11.10.2. Begin the analytical sequence as described in Section 11.4, above.

11.10.3. Prepare each sample (including batch QC) by partially filling a 40 mL VOA vial with reagent water. Spike 860 uL methanol extract into the vial. Fill the vial, cap, invert to mix, and place on the instrument.

11.10.3.1. If the sample was field preserved, set the autosampler to add internal standard and surrogate solutions prior to purging.

11.10.3.2. If the sample was laboratory preserved, add 4.3 uL internal standard solution prior to filling and capping the vial.

11.11. Waste Dilution

This is used for waste materials soluble in methanol.

11.11.1. Tare a clean 10 mL volumetric flask. Add approximately 1 g of the waste material and record the mass.

11.11.2. Add about 5-8 mL methanol, and swirl gently to mix. Dilute to the mark with methanol. Prepare sample for analysis as a methanol extract (Section 11.10).

11.11.3. On the instrument, begin the analytical sequence as described in Section 11.4, above. Use the batch QC (method blank and LCS) prepared for aqueous samples (Section 11.4). Recalculate the batch QC as though they were diluted waste, to keep values and units consistent with those of the sample.

11.12. Dilutions

If the response for any compound exceeds the working range of the GC/MS system, a dilution of the extract is prepared and analyzed. An appropriate dilution should be in the upper half of the calibration range. Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range, and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

11.12.1. Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and the baseline rise is less than half the height of the internal standards, or if individual non target peaks are less than twice the height of the internal standards, then the sample should be reanalyzed at a more concentrated dilution. This requirement is approximate and subject to analyst judgment.

11.12.2. Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will only be reported at client request, or in accordance with Federal programs, such as DoD.

11.12.3. Aqueous samples: Prepare the dilution in a 50 mL volumetric flask with reagent water. Fill a VOA vial with the dilution and analyze.

11.12.4. If the dilution required would use less than 1 uL of sample, then serial dilutions must be made in volumetric flasks.

11.12.4.1. The diluted concentration should be estimated to be in mid-calibration range.

11.12.5. Low-level solids: if subsampled from grab samples, a smaller amount (down to 1g) may be analyzed. If sample amounts less than 1g are required, or the samples are provided in EnCore samplers, a medium-level (methanol extract) analysis must be performed.

11.12.6. Medium-level (methanol extract) solids: Decrease the volume of methanol spiked into the VOA vial (Section 11.11.3). If the volume of methanol to be spiked is less than 5 uL, prepare a dilution of the methanol first.

12. CALCULATIONS/DATA REDUCTION

12.1. Qualitative identification

An analyte is identified by retention time and by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard reference may be obtained on the user's GC/MS by analysis of the calibration standards or from the NIST Library. Two criteria must be satisfied to verify identification: (1) elution of sample component at the same GC retention time as the standard component; and (2) correspondence of the sample component and the standard component characteristic ions. (Note: Care must be taken to ensure that spectral distortion due to co-elution is evaluated.)

- The sample component retention time must compare to within ± 0.2 min. of the retention time of the standard component. For reference, the standard must be run within the same twelve hours as the sample.

- All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) should be present in the sample spectrum.
- The relative intensities of ions should agree to within ±30% between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80 percent.)

12.1.1. If a compound cannot be verified by all the above criteria, but in the technical judgment of the analyst, the identification is correct, then the analyst shall report that identification and proceed with quantitation.

12.2. Tentatively Identified Compounds (TICs)

12.2.1. If a TIC compound is not part of the client target analyte list, but is calibrated on the instrument and is qualitatively and/or quantitatively identifiable, it must be quantitated based on the calibration, and narrated in Clouseau that it was qualitatively and quantitatively reported compared to a known standard that is in control. If the calibration is not in control, then it should still be narrated that it was reported compared to a known standard, however, that standard is not in control.

12.2.2. If the client requests components not associated with the calibration standards, a search of the NIST Library may be made for the purpose of tentative identification. Guidelines are:

12.2.2.1. Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) should be present in the sample spectrum.

12.2.2.2. The relative intensities of the major ions should agree to within 20%. (Example: If an ion shows an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30% and 70%).

12.2.2.3. Molecular ions present in the reference spectrum should be present in the sample spectrum.

12.2.2.4. Ions present in the sample spectrum, but not in the reference spectrum, should be reviewed for possible background contamination or presence of coeluting compounds.

12.2.2.5. Ions present in the reference spectrum, but not in the sample spectrum, should be reviewed for possible subtraction from the spectrum because of background contamination or coeluting peaks. (Data system reduction programs can sometimes create these discrepancies.)

12.2.2.6. Computer-generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual inspection of the sample with the nearest library searches should the analyst assign a tentative identification.

12.2.2.7. Any compound identified by the library search with a probability of 80% or less will be reported as UNKNOWN only. Any compound identified by the library search with 80% to 100% probability will be reported as the compound selected by the library search program. The only exception will be Aldol Condensate products, which will be reported as "Aldol Condensate Product", and not by the analyte name.

12.2.2.8. Compounds or peaks present in both the sample and blanks are not reported.

12.3. All manual or re-integration of chromatograms must be documented in accordance with Policy CA-QS-002 and the West Sacramento-specific addendum. Documentation includes, as a minimum, before and after copies of the chromatograms with a reference to the reason for re-integration. All manual integrations must undergo a second level review.

12.4. Calculations.

12.4.1. Relative response factor (RRF)

Equation 1

$$RRF = \frac{A_X \times C_{IS}}{A_{IS} \times C_X}$$

Where:

A_X = Area of the characteristic ion for the compound to be measured
A_{IS} = Area of the characteristic ion for the specific internal standard
C_{IS} = Concentration of the specific internal standard, ng/mL
C_X = Concentration of the compound being measured, ng/mL

12.4.2. Standard deviation (SD):

Equation 2

$$SD = \sqrt{\sum_{i=1}^{n} \frac{(X_i - X)^2}{n-1}}$$

Where:

X_i = Value of X at i
N = Number of points
X = Average value of X_i

12.4.3. Percent relative standard deviation (%RSD):

Equation 3

$$\%RSD = \frac{SD}{\overline{RRF}} \times 100$$

Where:

SD = Standard Deviation (Eq. 2)

$\overline{RRF}$ = Average of the relative response factors

12.4.4. Percent drift – Percent drift is used when average response factor calibration is not used (i.e., for calculating acceptance of continuing calibration of analytes calibrated using a linear or quadratic curve fit). For acceptance of analytes calculated using average response factor, see Section 12.4.5, Percent Difference.

Equation 4

$$\%Drift = \frac{C_{Found} - C_{Expected}}{C_{Expected}} \times 100$$

Where:

C = Concentration

12.4.5. Percent Difference – Percent difference is used when average response factor calibration is used.

Equation 5

$$\%Difference = \frac{RRF_{Std} - \overline{RRF}}{\overline{RRF}} \times 100$$

Where:

$\overline{RRF}$ = Average of the relative response factors

RRF_{std} = Relative Response factor of the continuing calibration verification

12.4.6. Calculating the "on-column" amount in an unknown sample using Average RRF:

Equation 6

$$C_X = \frac{A_X \times C_{IS}}{A_{IS} \times \overline{RRF}}$$

Where:

A_X = Area of the characteristic ion for the compound to be measured

A_{IS} = Area of the characteristic ion for the specific internal standard

C_{IS} = Concentration of the specific internal standard, ng/mL

C_X = Concentration of the compound being measured, ng/mL

$\overline{RRF}$ = Average response factor of the compound.

12.4.6.1. Calculation of TICs: The calculation of TICs (tentatively identified compounds) is identical to the above calculations with the following exceptions:

A_X = Area of the total ion chromatogram for the compound to be measured
A_{IS} = Area of the total ion chromatogram for the specific internal standard
$\overline{RRF}$ = Assumed to be equal to 1.

12.4.7. Calculating the "on-column" amount in an unknown sample using a linear fit, not forced through zero. (Based on the "Target" data system).

Equation 7

$$C_X = C_{IS} \times \left(b + \frac{A_X}{A_{IS} \times m1} \right)$$

Where:

A_X = Area of the characteristic ion for the compound to be measured
A_{IS} = Area of the characteristic ion for the specific internal standard
C_{IS} = Concentration of the specific internal standard, ng/mL
C_X = Concentration of the compound being measured, ng/mL
b = Constant as calculated by Target
$m1$ = First degree factor, as calculated by Target

12.4.8. Calculating Sample Concentrations

12.4.8.1. Concentration in an aqueous sample or a low-level solid sample (C_S)

Equation 8

$$C_S = C_X \times \frac{V_D}{V_I}$$

Where:

C_X = Concentration of the compound being measured, ng/mL (Eq. 7)
V_D = Default Purge Aliquot Size (g or mL)
V_I = Actual Purge Aliquot Size (g or mL)

12.4.8.2. Concentration in a medium-level solid sample (C_S)

Equation 9

$$C_S = C_X \times \frac{V_W}{V_I} \times \frac{V_M}{M_S}$$

Where:

C_X = Concentration of the compound being measured, ng/mL (Eq. 7)
V_W = Volume of Water used
V_I = Volume of methanol extract added to water
V_M = Volume of methanol added to solid during preservation
M_S = Mass of solid sample

Note: *Any required percent moisture correction occurs following entry into a LIMS database and not at the instrument. See SOP WS-OP-0013, "Determination of Percent Moisture" for details of determining and reporting soil moisture content.*

12.4.8.3. To calculate the concentration in a medium-level solid sample (C_S) accounting for percent moisture contribution (per Method 8000C), use Equation 9, above, but calculate V_M as noted below:

Equation 10

$$V_M = V_{MP} + \left(\frac{Ms \times \%M}{100} \right)$$

Where:

V_M = Volume of methanol added to solid during preservation plus the water content of the sample
V_{MP} = Volume of methanol added to solid during preservation
M_S = Mass of solid sample
$\%M$ = Percent moisture content of the sample (as measured using SOP WS-OP-0013)

Note: *The calculation above does not replace dry-weight correction. It compensates for the water contribution to the methanol used to preserve/extract the sample only. Any required percent moisture correction occurs following entry into a LIMS database and not at the instrument. See SOP WS-OP-0013, "Determination of Percent Moisture" for details of determining and reporting soil moisture content.*

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. VOA vials containing extracted acidic water and small amounts of methanol. Once analysis is completed, these are collected in plastic lined boxes in the lab. When the box is full, it is transferred to the waste disposal area where the vials are run through the vial eater for disposal.

15.2. VOA vials containing extracted soil samples, which will contain small amounts of methanol and possibly sodium bisulfate. Once analysis is completed, these are collected in plastic lined boxes in the lab. When the box is full, it is transferred to the waste disposal area. The hazardous waste specialist visually inspects each vial with extracted soil. If there is visible liquid in the vial, it is disposed of through the vial eater. If there is no visible liquid, the vial will be placed into a soil collection drum.

15.3. Aqueous acidic waste from sample analysis, which may contain small amounts of methanol and sodium bisulfate. This waste is collected in one gallon plastic carboys. When the carboy is full, it is taken to an H3 waste collection area, and is poured into a blue plastic LLE collection drum. When full to between two and six inches of the top, or after no more than 75 days, move the LLE drum to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III, December 1996, Sections 5000, 5030B, 5035, 8000B, and 8260B.

16.2. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 4th Edition, Method 5035A Draft Rev. 1, July 2002.

16.3. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 2nd Edition, Method 5030A Rev. 1, July 1992.

16.4. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, March 2003, Section 8000C.

17. METHOD MODIFICATIONS

17.1. The quantitation and qualifier ions for some compounds have been changed from those recommended in SW-846 in order to improve the reliability of qualitative identification.

18. ATTACHMENTS

18.1. Table 1 – 8260 Compounds and Reporting Limits

18.2. Table 2 – "Normal 8260" Standard Calibration levels (Aqueous)

18.3. Table 3 – 8260 Mix Liquid Curve Recipe (100 mL final volume)

18.4. Table 4 – Appendix IX Standard Calibration Levels (Aqueous Samples)

18.5. Table 5 – AP9/Oxy Liquid Curve Recipe (50 mL final volume)

18.6. Table 6 – "Normal 8260" Standard Calibration Levels (Solid Analysis)

18.7. Table 7 – "Normal 8260" Standard Low-Level Solid Curve Recipe (5 mL Final Volume)

18.8. Table 8 – Appendix 9 Standard Calibration Levels (Solid Samples)

18.9. Table 9 – Appendix 9 Low-level Solid Curve Recipes (5 mL final volumes)

18.10. Table 10 – Internal Standards

18.11. Table 11 – Surrogate Standards

18.12. Table 12 – LCS and MS/SD Spiking Components and Concentrations

18.13. Table 13 – BFB Key Ion Abundance Criteria

18.14. Table 14 – Characteristic Ions

18.15. Table 15 – Suggested Instrument Conditions

18.16. Appendix A – Gas Analysis by GC/MS based on SW-846, CA-LUFT, AK101 and Northwest Methods

19. REVISION HISTORY

19.1. WS-MS-0007, Revision 4.4, Effective 02/29/2012

19.1.1. Revised Section 7.5.1 from: "Once opened, gas stock standards are aliquoted to vials, each stored with minimum headspace for up to 2 months. Each vial is used for no more than two weeks" to "Each vial is used for no more than one week."

19.1.2. Revised Section 10.8.3.1 to read: "If the CCCs are not included in the list of compounds for a project, and therefore not included in the calibration standards, than all compounds **must** meet the 20% difference of drift criterion."

19.2. WS-MS-0007, Revision 4.3, Effective 12/23/2011

19.2.1. Inserted Section 8.1 into Appendix I (Gas Analysis by GC/MS Based on SW-846, CALUFT, AK101, and Northwest Methods) outlining the process for ADEC soil sample collection and preservation.

19.2.2. Editorial revisions.

19.3. WS-MS-0007, Revision 4.2, Effective 2/26/2010

19.3.1. Revised Section 6.8.3 to "#10 trap (Tenax/silica gel/carbon molecular sieve)."

19.3.2. Revised Section 8.2.2 to "…are preserved with sodium bisulfate / H_2O solution,".

19.3.3. Revised calibration levels in Tables 1 through 12.

19.3.4. Reversed upper part of Equation 4 and Equation 5 to correct signs in Section 12.4.3 and Section 12.4.4.

19.4. WS-MS-0007, Revision 4.1, Effective 9/04/2009

19.4.1. Added Section 1.6, "When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPP Implementation" must be checked and incorporated."

19.4.2. Inserted Section 10.1, "For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)"."

19.5. WS-MS-0007, Revision 4, Effective 12/03/2008

19.5.1. Updated to TestAmerica format.

19.5.2. Updated BFB tuning criteria to be compliant with the QAM.

19.5.3. Updated TIC qualification to be compliant with the QAM.

19.5.4. Added calculation for percent moisture compensation on methanol preserved samples.

19.5.5. Editorial changes.

19.6. WS-MS-0007, Revision 3, Effective 1/10/07

19.6.1. Directions and references for Method 524.2 have been removed.

19.6.2. Accommodations for newer instrumentation have been made, e.g., standards in volumetric flasks and 5 mL purge for aqueous samples.

19.6.3. Change forms have been incorporated. This updates the ICV criteria, the logic for processing initial calibrations, and the references for the preparation stage of the analysis.

19.6.4. Directions for EnCore samples have been clarified.

19.6.5. Modified purge temperature in Sections 2.3, 6.8.1, 6.9.2, 11.8.1, and Table 17 from 40ºC to 50ºC.

19.6.6. Removed reference to DB-624 megabore column that is no longer used.

19.6.7. Removed reference to PID and FID in Section 10.4.3.

Table 1
West Sacramento 8260 Compounds and Reporting Limits

Compound	CAS Number	Reporting Limits[1]		
		Water µg/L	Low soil µg/kg	Med. Soil µg/kg
Acetone	67-64-1	10	50	500
Acrolein	107-02-8	10	50	500
Acrylonitrile	107-13-1	20	100	500
Benzene	71-43-2	1.0	5.0	50
Bromobenzene	108-86-1	1.0	5.0	50
Bromochloromethane	74-97-5	1.0	5.0	50
Bromodichloromethane	75-27-4	1.0	5.0	50
Bromoform	75-25-2	1.0	5.0	50
Bromomethane	74-83-9	1.0	5.0	50
t-Butanol	75-65-0	50	250	1250
2-Butanone (MEK)	78-93-3	2.0	10	100
n-Butylbenzene	104-51-8	1.0	5.0	50
sec-Butylbenzene	135-98-8	1.0	5.0	50
tert-Butylbenzene	98-06-6	1.0	5.0	50
Carbon disulfide	75-15-0	2.0	10	100
Carbon tetrachloride	56-23-5	1.0	5.0	50
Chlorobenzene	108-90-7	1.0	5.0	50
Chloroprene	126-99-8	2.0	10	100
Dibromochloromethane	124-48-1	1.0	5.0	50
Chloroethane	75-00-3	1.0	5.0	50
2-Chloroethyl vinyl ether	110-75-8	2.0	10	100
Chloroform	67-66-3	1.0	5.0	50
1-Chlorohexane	544-10-5	2.0	10	100
Chloromethane	74-87-3	1.0	5.0	50
Allyl chloride	107-05-1	2.0	10	100
2-Chlorotoluene	95-49-8	1.0	5.0	50
4-Chlorotoluene	106-43-4	1.0	5.0	50
Cyclohexane	110-82-7	2.0	10	100
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	2.0	10	100
1,2-Dibromoethane (EDB)	106-93-4	2.0	10	100
Dibromomethane	74-95-3	1.0	5.0	50
1,2-Dichlorobenzene	95-50-1	1.0	5.0	50
1,3-Dichlorobenzene	541-73-1	1.0	5.0	50
1,4-Dichlorobenzene	106-46-7	1.0	5.0	50
trans-1,4-Dichloro-2-butene	110-57-6	2.0	10	100
Dichlorodifluoromethane (Freon 12)	75-71-8	1.0	5.0	50
1,1-Dichloroethane	75-34-3	1.0	5.0	50
1,2-Dichloroethane	107-06-2	1.0	5.0	50

Table 1
West Sacramento 8260 Compounds and Reporting Limits

Compound	CAS Number	Reporting Limits[1]		
		Water µg/L	Low soil µg/kg	Med. Soil µg/kg
cis-1,2-Dichloroethene	156-59-2	1.0	5.0	50
trans-1,2-Dichloroethene	156-60-5	1.0	5.0	50
1,1-Dichloroethene	75-35-4	1.0	5.0	50
1,2-Dichloroethene (total)	540-5-90	1.0	5.0	50
1,2-Dichloropropane	78-87-5	1.0	5.0	50
1,3-Dichloropropane	142-28-9	1.0	5.0	50
2,2-Dichloropropane	594-20-7	1.0	5.0	50
cis-1,3-Dichloropropene	10061-01-5	1.0	5.0	50
trans-1,3-Dichloropropene	10061-02-6	1.0	5.0	50
1,1-Dichloropropene	563-58-6	1.0	5.0	50
Diisopropyl ether	108-20-3	2.0	10	100
1,4-Dioxane	123-91-1	50	250	1250
Tert-amyl methyl ether	994-05-8	2.0	10	100
Tert-butyl ethyl ether	637-92-3	2.0	10	100
Ethylbenzene	100-41-4	1.0	5.0	50
Ethyl methacrylate	97-63-2	2.0	10.0	100
Hexachlorobutadiene	87-68-3	1.0	5.0	50
Hexane	110-54-3	2.0	10	100
2-Hexanone	591-78-6	2.0	10	100
Iodomethane	74-88-4	2.0	10	100
Isobutyl alcohol	78-83-1	20	100	5000
Isopropylbenzene	98-82-8	1.0	5.0	50
Isopropyl ether	108-20-3	2.0	10	100
p-Isopropyltoluene	99-87-6	1.0	5.0	50
Methacrylonitrile	126-98-7	2.0	10	100
Methylene chloride	75-09-2	1.0	10	100
Methyl methacrylate	80-62-6	2.0	10	100
4-Methyl-2-pentanone (MIBK)	108-10-1	2.0	10	100
Methyl tert-butyl ether (MTBE)	1634-04-4	2.0	10	100
Naphthalene	91-20-3	1.0	5.0	50
Propionitrile	107-12-0	2.0	10	100
n-Propylbenzene	103-65-1	1.0	5.0	50
Styrene	100-42-5	1.0	5.0	50
1,1,1,2-Tetrachloroethane	630-20-6	1.0	5.0	50
1,1,2,2-Tetrachloroethane	79-34-5	1.0	5.0	50
Tetrachloroethene	127-18-4	1.0	5.0	50
Tetrahydrofuran	109-99-9	5.0	NA	NA
Toluene	108-88-3	1.0	5.0	50
1,2,3-Trichlorobenzene	87-61-6	1.0	5.0	50
1,2,4-Trichlorobenzene	120-82-1	1.0	5.0	50
1,1,1-Trichloroethane	71-55-6	1.0	5.0	50
1,1,2-Trichloroethane	79-00-5	1.0	5.0	50
Trichloroethene	79-01-6	1.0	5.0	50

Table 1
West Sacramento 8260 Compounds and Reporting Limits

Compound	CAS Number	Reporting Limits[1]		
		Water µg/L	Low soil µg/kg	Med. Soil µg/kg
Trichlorofluoromethane (Freon 11)	75-69-4	1.0	5.0	50
1,2,3-Trichloropropane	96-18-4	1.0	5.0	50
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	2.0	10	100
1,2,4-Trimethylbenzene	95-63-6	1.0	5.0	50
1,3,5-Trimethylbenzene	108-67-8	1.0	5.0	50
Vinyl acetate	108-05-4	2.0	10	100
Vinyl chloride	75-01-4	1.0	5.0	50
m-Xylene & p-Xylene	136777-61-2	1.0	5.0	50
o-Xylene	95-47-6	1.0	5.0	50
Xylenes (total)	1330-20-7	1.0	5.0	50

[1] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

[2] 2-Chloroethyl vinyl ether cannot be recovered from acid preserved samples, including solids preserved with sodium bisulfate solution.

Table 2

"Normal 8260" Standard Calibration Levels (Aqueous and Medium Level Solid Analysis)

Compound	Stock ug/mL	Calibration Level ug/L							
		1	2	3	4	5	6	7	8
Surrogate									
1,2-Dichloroethane-d4 (Surrogate)	100	--	2.0	4.0	10	20	40	60	80
Toluene-d8 (Surrogate)	100	--	2.0	4.0	10	20	40	60	80
4-Bromofluorobenzene (Surrogate)	100	--	2.0	4.0	10	20	40	60	80
TCL Mix									
Dichlorodifluoromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Chloromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Vinyl chloride	200	0.25	0.5	1.0	4.0	20	40	60	80
Chloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Bromomethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Trichlorofluoromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1-Dichloroethene	200	0.25	0.5	1.0	4.0	20	40	60	80
Carbon disulfide	200	0.25	0.5	1.0	4.0	20	40	60	80
Methylene chloride	200	0.25	0.5	1.0	4.0	20	40	60	80
trans-1,2-Dichloroethene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1-Dichloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
2,2-Dichloropropane	200	0.25	0.5	1.0	4.0	20	40	60	80
cis-1,2-Dichloroethene	200	0.25	0.5	1.0	4.0	20	40	60	80
Bromochloromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Chloroform	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1,1-Trichloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1-Dichloropropene	200	0.25	0.5	1.0	4.0	20	40	60	80
Carbon tetrachloride	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2-Dichloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Benzene	200	0.25	0.5	1.0	4.0	20	40	60	80
Trichloroethene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2-Dichloropropane	200	0.25	0.5	1.0	4.0	20	40	60	80
Dibromomethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Bromodichloromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
cis-1,3-Dichloropropene	200	0.25	0.5	1.0	4.0	20	40	60	80
Toluene	200	0.25	0.5	1.0	4.0	20	40	60	80
trans-1,3-Dichloropropene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1,2-Trichloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Tetrachloroethene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,3-Dichloropropane	200	0.25	0.5	1.0	4.0	20	40	60	80
Dibromochloromethane	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2-Dibromoethane	200	0.25	0.5	1.0	4.0	20	40	60	80
1-Chlorohexane	200	0.25	0.5	1.0	4.0	20	40	60	80
Ethylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
Chlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1,1,2-Tetrachloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
m and p Xylenes	400	0.50	1.0	2.0	8.0	40	80	120	160
o-xylene	200	0.25	0.5	1.0	4.0	20	40	60	80
Styrene	200	0.25	0.5	1.0	4.0	20	40	60	80
Bromoform	200	0.25	0.5	1.0	4.0	20	40	60	80
Isopropylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2,3-Trichloropropane	200	0.25	0.5	1.0	4.0	20	40	60	80

Table 2

"Normal 8260" Standard Calibration Levels (Aqueous and Medium Level Solid Analysis)

Compound	Stock ug/mL	Calibration Level ug/L							
		1	2	3	4	5	6	7	8
Bromobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,1,2,2-Tetrachloroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
n-Propylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
2-Chlorotoluene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,3,5-Trimethylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
4-Chlorotoluene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2,4-Trimethylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
T-Butylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
Sec-Butylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,3-Dichlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
p-Isopropyltoluene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,4-Dichlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2-Dichlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
n-Butylbenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2-Dibromo-3-chloropropane	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2,3-Trichlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
Hexachlorobutadiene	200	0.25	0.5	1.0	4.0	20	40	60	80
Naphthalene	200	0.25	0.5	1.0	4.0	20	40	60	80
1,2,3-Trichlorobenzene	200	0.25	0.5	1.0	4.0	20	40	60	80
ODD Mix									
Acetone	200	0.25	0.5	1.0	4.0	20	40	60	80
Acrylonitrile	2000	2.5	5.0	10	40	200	400	600	800
Trichlorotrifluoroethane	200	0.25	0.5	1.0	4.0	20	40	60	80
Methyl *tert*-butyl ether (MTBE)	200	0.25	0.5	1.0	4.0	20	40	60	80
2-Butanone	200	0.25	0.5	1.0	4.0	20	40	60	80
1,4-Dioxane	5000	6.25	12.5	25	100	500	1000	1500	2000
t-Butanol	5000	6.25	12.5	25	100	500	1000	1500	2000
2-Chloroethyl vinyl ether	200	0.25	0.5	1.0	4.0	20l	40	60	80
4-Methyl-2-pentanone	200	0.25	0.5	1.0	4.0	20	40	60	80
2-Hexanone	200	0.25	0.5	1.0	4.0	20	40	60	80
Vinyl Acetate									
Vinyl acetate	200	0.25	0.5	1.0	4.0	20	40	60	80
Methanolic TVPH Surrogate									
a,a,a-Trifluorotoluene	100	--	2.0	4.0	10	20	40	60	80

Table 3

8260 Liquid Curve
100 mL

Calibration Point	Final Volume (mL)	Concentration (µg/L)	Auto IS (500 µg/mL)	Surrogate (100 µg/mL)	*ICAL mix (5-10 µg/mL)	TCLA & TCLB (200 µg/mL)	ODD #1 & #2 (200 – 5000 µg/mL)	Vinyl Acetate (2000 µg/mL)
1	100	0.25/0.50	1.0 µL	--	5.0 µL	---	---	---
2	100	0.5/1.0	1.0 µL	1 µL	10 µL	---	---	---
3	100	1.0/2.0	1.0 µL	2 µL	20 µL	---	---	---
4	100	4	1.0 µL	4 µL	---	2 µL	2 µL	2 µL
5 (CCV)	100	20	1.0 µL	20 µL	---	10 µL	10 µL	10 µL
6	100	40	1.0 µL	40 µL	---	20 µL	20 µL	20 µL
7	100	60	1.0 µL	60 µL	---	30 µL	30 µL	30 µL
8	100	80	1.0 µL	80 µL	---	40 µL	40 µL	40 µL

BFB	1µL	500µg/mL	Direct Inject

*ICAL Mix (5 – 10µg/mL = 400µL FV (350µL MeOH + 10µL TCLA + 10µL TCLB + 10µL ODD #1 + 10µL ODD #2 + 10µL VA)

Table 4

Appendix IX Standard Calibration Levels (Aqueous and Medium Level Solid Analysis)

Compound	Stock Solution ug/mL	Calibration Level (ug/L)						
		Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
AP9 A solution								
Iodomethane	200	2	4	10	20	40	60	80
Allyl Chloride	200	2	4	10	20	40	60	80
Isopropyl ether	200	2	4	10	20	40	60	80
tert-Butyl ethyl ether	200	2	4	10	20	40	60	80
Propionitrile	200	2	4	10	20	40	60	80
Methacrylonitrile	200	2	4	10	20	40	60	80
Tetrahydrofuran	200	2	4	10	20	40	60	80
Isobutanol	2000	20	40	100	200	400	600	800
tert-Amyl methyl ether	200	2	4	10	20	40	60	80
Methyl methacrylate	200	2	4	10	20	40	60	80
Ethyl methacrylate	200	2	4	10	20	40	60	80
t-1,4-Dichloro-2-butene	200	2	4	10	20	40	60	80
AP9 B								
Hexane	200	2	4	10	20	40	60	80
Cyclohexane	200	2	4	10	20	40	60	80
Chloroprene	200	2	4	10	20	40	60	80
ACROLEIN								
Acrolein	2000	20	40	100	200	400	600	800

Table 5

AP9/Oxy Curve Recipe (50mL final Volume) (Aqueous and Medium Level Solid Analysis)

Calib Level	IS (100 ug/mL)	AP9 A (200-5000) ug/mL	AP9 B 200 ug/mL	Acrolein 2000 ug/mL
2	10 uL	1 uL	1 uL	1 uL
3	10 uL	2 uL	2 uL	2 uL
4	10 uL	5 uL	5 uL	5 uL
5	10 uL	10 uL	10 uL	10 uL
6	10 uL	20 uL	20 uL	20 uL
7	10 uL	30 uL	30 uL	30 uL
8	10 uL	40 uL	40 uL	40 uL

Table 6									
"Normal 8260" Calibration Level (Low Level Solid Analysis)									
Compound	Stock ug/mL	Calibration Level ug/L							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Surrogate									
1,2-Dichloroethane-d4 (Surrogate)	100	--	--	10	20	50	100	200	400
Toluene-d8 (Surrogate)	100	--	--	10	20	50	100	200	400
4-Bromofluorobenzene (Surrogate)	100	--	--	10	20	50	100	200	400
TCL Mix									
Dichlorodifluoromethane	200	2.5	5	10	20	50	100	200	400
Chloromethane	200	2.5	5	10	20	50	100	200	400
Vinyl chloride	200	2.5	5	10	20	50	100	200	400
Chloroethane	200	2.5	5	10	20	50	100	200	400
Bromomethane	200	2.5	5	10	20	50	100	200	400
Trichlorofluoromethane	200	2.5	5	10	20	50	100	200	400
1,1-Dichloroethene	200	2.5	5	10	20	50	100	200	400
Carbon disulfide	200	2.5	5	10	20	50	100	200	400
Methylene chloride	200	2.5	5	10	20	50	100	200	400
trans-1,2-Dichloroethene	200	2.5	5	10	20	50	100	200	400
1,1-Dichloroethane	200	2.5	5	10	20	50	100	200	400
2,2-Dichloropropane	200	2.5	5	10	20	50	100	200	400
cis-1,2-Dichloroethene	200	2.5	5	10	20	50	100	200	400
Bromochloromethane	200	2.5	5	10	20	50	100	200	400
Chloroform	200	2.5	5	10	20	50	100	200	400
1,1,1-Trichloroethane	200	2.5	5	10	20	50	100	200	400
1,1-Dichloropropene	200	2.5	5	10	20	50	100	200	400
Carbon tetrachloride	200	2.5	5	10	20	50	100	200	400
1,2-Dichloroethane	200	2.5	5	10	20	50	100	200	400
Benzene	200	2.5	5	10	20	50	100	200	400
Trichloroethene	200	2.5	5	10	20	50	100	200	400
1,2-Dichloropropane	200	2.5	5	10	20	50	100	200	400
Dibromomethane	200	2.5	5	10	20	50	100	200	400
Bromodichloromethane	200	2.5	5	10	20	50	100	200	400
cis-1,3-Dichloropropene	200	2.5	5	10	20	50	100	200	400
Toluene	200	2.5	5	10	20	50	100	200	400
trans-1,3-Dichloropropene	200	2.5	5	10	20	50	100	200	400
1,1,2-Trichloroethane	200	2.5	5	10	20	50	100	200	400
Tetrachloroethene	200	2.5	5	10	20	50	100	200	400
1,3-Dichloropropane	200	2.5	5	10	20	50	100	200	400
Dibromochloromethane	200	2.5	5	10	20	50	100	200	400
1,2-Dibromomethane	200	2.5	5	10	20	50	100	200	400

Table 6									
"Normal 8260" Calibration Level (Low Level Solid Analysis)									
Compound	Stock ug/mL	**Calibration Level ug/L**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1-Chlorohexane	200	2.5	5	10	20	50	100	200	400
Ethylbenzene	200	2.5	5	10	20	50	100	200	400
Chlorobenzene	200	2.5	5	10	20	50	100	200	400
1,1,1,2-Tetrachloroethane	200	2.5	5	10	20	50	100	200	400
m and p Xylenes	200	2.5	5	10	20	50	100	200	400
o-xylene	200	2.5	5	10	20	50	100	200	400
Styrene	200	2.5	5	10	20	50	100	200	400
Bromoform	200	2.5	5	10	20	50	100	200	400
Isopropylbenzene	200	2.5	5	10	20	50	100	200	400
1,2,3-Trichloropropane	200	2.5	5	10	20	50	100	200	400
Bromobenzene	200	2.5	5	10	20	50	100	200	400
1,1,2,2-Tetrachloroethane	200	2.5	5	10	20	50	100	200	400
n-Propylbenzene	200	2.5	5	10	20	50	100	200	400
2-Chlorotoluene	200	2.5	5	10	20	50	100	200	400
1,3,5-Trimethylbenzene	200	2.5	5	10	20	50	100	200	400
4-Chlorotoluene	200	2.5	5	10	20	50	100	200	400
1,2,4-Trimethylbenzene	200	2.5	5	10	20	50	100	200	400
t-Butylbenzene	200	2.5	5	10	20	50	100	200	400
Sec-Butylbenzene	200	2.5	5	10	20	50	100	200	400
1,3-Dichlorobenzene	200	2.5	5	10	20	50	100	200	400
p-Isopropyltoluene	200	2.5	5	10	20	50	100	200	400
1,4-Dichlorobenzene	200	2.5	5	10	20	50	100	200	400
1,2-Dichlorobenzene	200	2.5	5	10	20	50	100	200	400
n-Butylbenzene	200	2.5	5	10	20	50	100	200	400
1,2-Dibromo-3-chloropropane	200	2.5	5	10	20	50	100	200	400
1,2,3-Trichlorobenzene	200	2.5	5	10	20	50	100	200	400
Hexachlorobutadiene	200	2.5	5	10	20	50	100	200	400
Naphthalene	200	2.5	5	10	20	50	100	200	400
1,2,3-Trichlorobenzene	200	2.5	5	10	20	50	100	200	400
ODD Mix									
Acetone	200	2.5	5	10	20	50	100	200	400
Acrylonitrile	2000	25	50	100	200	500	1000	2000	4000
Trichlorotrifluoroethane	200	2.5	5	10	20	50	100	200	400
Methyl *tert*-butyl ether (MTBE)	200	2.5	5	10	20	50	100	200	400
2-Butanone	200	2.5	5	10	20	50	100	200	400
1,4-Dioxane	5000	62.5	125	250	500	1250	2500	5000	10000
t-Butanol	5000	62.5	125	250	500	1250	2500	5000	10000
2-Chloroethyl vinyl ether	200	2.5	5	10	20	50	100	200	400

Table 6									
"Normal 8260" Calibration Level (Low Level Solid Analysis)									
Compound	**Stock ug/mL**	**Calibration Level ug/mL**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
4-Methyl-2-pentanone	200	2.5	5	10	20	50	100	200	400
2--Hexanone	200	2.5	5	10	20	50	100	200	400
Vinyl Acetate									
Vinyl acetate	200	2.5	5	10	20	50	100	200	400

Tabled 7

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

8260 Low Soil Curve

5.0g in (10ml H2O)

Calibration point	Concentration (ug/Kg)	Final Volume	Internal Standard (250 ug/mL) Autospike	Surrogate (100 ug/mL)	TCL A (100 ug/mL)	TCL B (100 ug/mL)	ODD Mix #1 (100 ug/mL)	ODD Mix #2 (100 ug/mL)	Vinyl Acetate (100 ug/mL)
1	1	10 mL	1.0 uL	2.0 uL (a)	N/A	N/A	N/A	N/A	N/A
2	2.5	10 mL	1.0 uL	5 uL (a)	N/A	N/A	N/A	N/A	N/A
3	5	10 mL	1.0 uL	10 uL (a)	N/A	N/A	N/A	N/A	N/A
4	10	10 mL	1.0 uL	20 uL (a)	N/A	N/A	N/A	N/A	N/A
5	50	10 mL	1.0 uL	2.5 uL	2.5 uL	2.5 uL	2.5 uL	2.5 uL	2.5 uL
6 (CCV)	100	10 mL	1.0 uL	5.0 uL	5 uL	5 uL	5 uL	5 uL	5 uL
7	200	10 mL	1.0 uL	10 uL	10 uL	10 uL	10 uL	10 uL	10 uL
8	400	10 mL	1.0 uL	20 uL	20 uL	20 uL	20 uL	20 uL	20 uL

(a) = 50uL of Surrogate, 25ul of TCL A, TCL B, Odd Mix #1, Odd Mix #2, and Vinyl Acetate diluted to FV of 1.0mL in MeOH.

Analyst: _____ Date: _____

Daily QC

Calibration point	Final Volume	Concentration (ug/L)	Internal Standard (250 ug/mL) Autospike	Surrogate (500 ug/mL) Autospike	Secondary Sources (100 ug/mL)
LCS/LCSD	10 mL	100	1.0 uL	1.0 uL	5 uL
MS/MSD	10 mL	100	1.0 uL	1.0 uL	5 uL
Sample	10 mL	100	1.0 uL	1.0 uL	N/A

Analyst: _____ Date: _____

Comments : _____

Q:\FORMS\Checklists\QA-633_8260 Low Soil Curve QA-633 07/26/2011 SR

Table 8

Appendix IX Standard Calibration Levels (Low-Level Solid Samples)

Compound	Stock Solution ug/mL	Calibration Level (ng/g)							
		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
AP9/OXY solution									
Iodomethane	200	2.5	5	10	20	50	100	200	400
Allyl Chloride	200	2.5	5	10	20	50	100	200	400
Isopropyl ether	200	2.5	5	10	20	50	100	200	400
tert-Butyl ethyl ether	200	2.5	5	10	20	50	100	200	400
Propionitrile	200	2.5	5	10	20	50	100	200	400
Methacrylonitrile	200	2.5	5	10	20	50	100	200	400
Tetrahydrofuran	200	2.5	5	10	20	50	100	200	400
Isobutanol	2000	25	50	100	200	500	1000	2000	4000
tert-Amyl methyl ether	200	2.5	5	10	20	50	100	200	400
Methyl methacrylate	200	2.5	5	10	20	50	100	200	400
Ethyl methacrylate	200	2.5	5	10	20	50	100	200	400
t-1,4-Dichloro-2-butene	200	2.5	5	10	20	50	100	200	400
CHLOROPRENE									
Chloroprene	200	2.5	5	10	20	50	100	200	400
ACROS MIX									
Acrolein	2000	25	50	100	200	500	1000	2000	4000
Acrylonitrile	2000	25	50	100	200	500	1000	2000	4000
HEXANE/CYCLOHEXANE									
Hexane	200	2.5	5	10	20	50	100	200	400
Cyclohexane	200	2.5	5	10	20	50	100	200	400

Table 9

Appendix IX Low-Level Solid Curve Recipe (5.0 g 10 mL purge)

Calib Level	Concentration	Final Volume H2O	IS (250 µg/mL) Autospike	AP9 A (200-5000 µg,/mL)	AP9 B (200-5000 µg,/mL)	Acrolein (2000 µg/mL)
1	2.5	10 mL	1.0 uL	2.5 µL (a)		2.5 µL (b)
2	5	10 mL	1.0 uL	5 µL (a)		5 µL (b)
3	10	10 mL	1.0 uL	10 µL (a)		10 µL (b)
4	20	10 mL	1.0 uL	20 µL (a)		20 µL (b)
5	50	10 mL	1.0 uL	50 µL (a)		50 µL (b)
6 (ccv)	100	10 mL	1.0 uL	2.5 µL	2.5 µL	2.5 µL
7	200	10 mL	1.0 uL	5 µL	5 µL	5 µL
8	400	10 mL	1.0 uL	10 µL	10 µL	10 µL

(a) = 250µL of the A P9 A and AP9 B combined and diluted to 1.0 mL in MeOH.
(b) = 250 µL of the Acrolein standard diluted to 1.0 mL in water.l

`

Table 10

Internal Standards

Internal Standard Component	Quantitation ion	Solution Concentration (µg/mL)	Concentration in Sample	
			Aqueous (ng/mL)	Soil (ng/g)
Aqueous and Medium Solids				
1,4-Difluorobenzene	114	50	10	500
Chlorobenzene-d5	117	50	10	500
1,4-Dichlorobenzene-d4	152	50	10	500
Low-Level Solids				
1,4-Difluorobenzene	114	500	--	50
Chlorobenzene-d5	117	500	--	50
1,4-Dichlorobenzene-d4	152	500	--	50

Table 11

Surrogate Standards

Surrogate Standard Component	Solution Concentration (µg/mL)	Concentration in Sample	
		Aqueous (ng/mL)	Soil (ng/g)
Aqueous and Medium Solids			
Dibromofluoromethane	100	20	1000
1,2-Dichloroethane-d_4	100	20	1000
Toluene-d_8	100	20	1000
4-Bromofluorobenzene	100	20	1000
Low-Level Solids			
Dibromofluoromethane	500	--	100
1,2-Dichloroethane-d_4	500	--	100
Toluene-d_8	500	--	100
4-Bromofluorobenzene	500	--	100

Table 12
LCS and MS/SD Spiking Components and Concentrations

Compound	Solution Concentration (ug/ml)	Spiking Level		
		Water (ug/L)	Low Soil (ug/kg)	Medium Soil (ug/kg)
Acetone	200	20	100	1000
Acetonitrile	200	20	100	1000
Acrolein	2000	200	1000	10,000
Acrylonitrile	2000	200	1000	10,000
Benzene (1)	200	20	100	1000
Bromobenzene	200	20	100	1000
Bromochloromethane	200	20	100	1000
Bromodichloromethane	200	20	100	1000
Bromoform	200	20	100	1000
Bromomethane	200	20	100	1000
t-Butanol	5050	500	2500	25,000
2-Butanone (MEK)	200	20	100	1000
n-Butylbenzene	200	20	100	1000
sec-Butylbenzene	200	20	100	1000
tert-Butylbenzene	200	20	100	1000
Carbon disulfide	200	20	100	1000
Carbon tetrachloride	200	20	100	1000
Chlorobenzene (1)	200	20	100	1000
Chloroprene	200	20	100	1000
Dibromochloromethane	200	20	100	1000
Chloroethane	200	20	100	1000
2-Chloroethyl vinyl ether	200	20	100	1000
Chloroform	200	20	100	1000
1-Chlorohexane	200	20	100	1000
Chloromethane	200	20	100	1000
Allyl chloride	200	20	100	1000
2-Chlorotoluene	200	20	100	1000
4-Chlorotoluene	200	20	100	1000
1,2-Dibromo-3-chloropropane (DBCP)	200	20	100	1000
1,2-Dibromoethane (EDB)	200	20	100	1000
Dibromomethane	200	20	100	1000
1,2-Dichlorobenzene	200	20	100	1000
1,3-Dichlorobenzene	200	20	100	1000
1,4-Dichlorobenzene	200	20	100	1000
trans-1,4-Dichloro-2-butene	200	20	100	1000
Dichlorodifluoromethane (Freon 12)	200	20	100	1000
1,1-Dichloroethane	200	20	100	1000
1,2-Dichloroethane	200	20	100	1000
cis-1,2-Dichloroethene	200	20	100	1000
trans-1,2-Dichloroethene	200	20	100	1000
1,1-Dichloroethene (1)	200	20	100	1000

Table 12
LCS and MS/SD Spiking Components and Concentrations

Compound	Solution Concentration (ug/ml)	Spiking Level		
		Water (ug/L)	Low Soil (ug/kg)	Medium Soil (ug/kg)
1,2-Dichloropropane	200	20	100	1000
1,3-Dichloropropane	200	20	100	1000
2,2-Dichloropropane	200	20	100	1000
cis-1,3-Dichloropropene	200	20	100	1000
trans-1,3-Dichloropropene	200	20	100	1000
1,1-Dichloropropene	200	20	100	1000
1,4-Dioxane	5000	500	2500	25,000
Tert-amyl methyl ether	200	20	100	1000
Tert-butyl ethyl ether	200	20	100	1000
Ethylbenzene	200	20	100	1000
Ethyl methacrylate	200	20	100	1000
Hexachlorobutadiene	200	20	100	1000
Hexane	200	20	100	1000
2-Hexanone	200	20	100	1000
Iodomethane	200	20	100	1000
Isobutyl alcohol	2000	500	2500	25,000
Isopropylbenzene	200	20	100	1000
Isopropyl ether	200	20	100	1000
p-Isopropyltoluene	200	20	100	1000
Methacrylonitrile	200	20	100	1000
Methylene chloride	200	20	100	1000
Methyl methacrylate	200	20	100	1000
4-Methyl-2-pentanone (MIBK)	200	20	100	1000
Methyl tert-butyl ether (MTBE)	200	20	100	1000
Naphthalene	200	20	100	1000
Propionitrile	200	20	100	1000
n-Propylbenzene	200	20	100	1000
Styrene	200	20	100	1000
1,1,1,2-Tetrachloroethane	200	20	100	1000
1,1,2,2-Tetrachloroethane	200	20	100	1000
Tetrachloroethene	200	20	100	1000
Toluene (1)	200	20	100	1000
1,2,3-Trichlorobenzene	200	20	100	1000
1,2,4-Trichlorobenzene	200	20	100	1000
1,1,1-Trichloroethane	200	20	100	1000
1,1,2-Trichloroethane	200	20	100	1000
Trichloroethene (1)	200	20	100	1000
Trichlorofluoromethane (Freon 11)	200	20	100	1000
1,2,3-Trichloropropane	200	20	100	1000
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	200	20	100	1000
1,2,4-Trimethylbenzene	200	20	100	1000

Table 12
LCS and MS/SD Spiking Components and Concentrations

Compound	Solution Concentration (ug/ml)	Spiking Level		
		Water (ug/L)	Low Soil (ug/kg)	Medium Soil (ug/kg)
1,3,5-Trimethylbenzene	200	20	100	1000
Vinyl acetate	200	20	100	1000
Vinyl chloride	200	20	100	1000
m-Xylene & p-Xylene	200	40	200	2000
o-Xylene	200	20	100	1000

(1) Laboratory default control analytes.

Table 13
BFB Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15% to 40% of Mass 95
75	30% to 60% of Mass 95
95	Base Peak, 100% Relative Abundance
96	5% to 9% of Mass 95
173	Less Than 2% of Mass 174
174	Greater Than 50% of Mass 95
175	5% to 9% of Mass 174
176	Greater Than 95%, But Less Than 101% of Mass 174
177	5% to 9% of Mass 176

Table 14				
Characteristic ions				
Compound	Approximate Retention Time (min)	Primary[4]	Secondary	Tertiary
Internal Standards				
1,4-Difluorobenzene	7.467	114	63	88
Chlorobenzene-d5	12.395	117		
1,4 Dichlorobenzene-d4	16.908	152		
Surrogates				
1,2-Dichloroethane-d4 [1]	6.777	65	102	67
Toluene-d8	9.852	98	100	99
4-Bromofluorobenzene	14.642	95	174	176
Target Analytes				
Dichlorodifluoromethane (Freon 12)	1.810	85	87	50
Chloromethane	1.988	50	52	49
Vinyl chloride	2.086	62	64	
Bromomethane	2.411	94	96	93
Chloroethane	2.500	64	66	49
Trichlorofluoromethane (Freon 11) [1,2]	2.776	101	103	66
Acrolein [1,2]	3.229	56	55	
1,1-Dichloroethene [2]	3.338	96	61	98
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) [3]	3.357	101	151	103
Acetone [1,2]	3.397	43	58	
Iodomethane	3.495	142	127	
Carbon disulfide	3.584	76	78	44
Acetonitrile [1,2]	3.751	40	41	39
Allyl chloride	3.761	76	41	39
Methylene chloride	3.909	84	49	86
t-Butanol [3]	4.125	59	41	
Acrylonitrile	4.214	53	52	
trans-1,2-Dichloroethene	4.264	96	61	98
Methyl tert-butyl ether (MTBE) [3]	4.264	73	41	57
1,1-Dichloroethane	4.796	63	65	83
Vinyl acetate	4.905	43	86	44
Chloroprene [3]	4.924	53	88	
Isopropylbenzene [1,2]	4.933	45	87	43
Tert-butyl ethyl ether [3]	4.943	59	87	
2,2-Dichloropropane	5.595	77	41	97
cis-1,2-Dichloroethene	5.605	96	61	98
2-Butanone (MEK) [1,2,5]	5.634	43	72	57
Propionitrile	5.762	54	55	
Methacrylonitrile	5.929	41	39	67
Bromochloromethane	5.930	128	49	130
Tetrahydrofuran [3]	6.066	42	41	72
Chloroform	6.068	83	85	47

Table 14				
Characteristic ions				
Compound	Approximate Retention Time (min)	Primary[4]	Secondary	Tertiary
1,1,1-Trichloroethane	6.324	97	61	99
1,1-Dichloropropene [2]	6.561	75	39	110
Carbon tetrachloride	6.570	117	119	121
Isobutyl alcohol	6.865	43	74	
Benzene	6.866	78	77	
1,2-Dichloroethane	6.896	62	64	98
Tert-amyl methyl ether [3]	7.091	73	45	
Trichloroethene	7.871	95	130	132
1,2-Dichloropropane [2]	8.207	63	62	64
Dibromomethane	8.394	93	174	172
Methyl methacrylate [1,2]	8.462	41	69	
1,4-Dioxane	8.482	88	58	
Bromodichloromethane [2]	8.670	83	85	47
2-Chloroethyl vinyl ether [2]	9.202	63	106	43
cis-1,3-Dichloropropene [2]	9.419	75	77	110
4-Methyl-2-pentanone (MIBK) [1,2]	9.705	43	58	100
Toluene	9.961	92	91	65
trans-1,3-Dichloropropene [2]	10.375	75	77	110
Ethyl methacrylate	10.611	69	41	
1,1,2-Trichloroethane [1,2]	10.680	97	83	99
Tetrachloroethene [1,2]	10.917	166	164	129
1,3-Dichloropropane	10.976	76	78	
2-Hexanone	11.203	43	58	100
Dibromochloromethane	11.360	129	127	208
1,2-Dibromoethane (EDB)	11.538	107	109	
Chlorobenzene	12.454	112	77	114
1-Chlorohexane [3]	12.484	91	41	55
1,1,1,2-Tetrachloroethane [2]	12.622	131	133	117
Ethylbenzene [1,2]	12.691	106	91	51
m-Xylene & p-Xylene	12.908	106	91	105
o-Xylene	13.647	106	91	
Styrene	13.676	104	103	78
Bromoform [2]	14.002	173	171	175
Isopropyl ether [3]	14.386	105	120	77
Bromobenzene [2]	14.899	156	77	58
1,1,2,2-Tetrachloroethane [2]	14.987	83	85	95
1,2,3-Trichloropropane [2]	15.027	75	110	112
trans-1,4-Dichloro-2-butene [1,2]	15.105	89	75	53
n-Propylbenzene	15.184	91	120	
2-Chlorotoluene	15.303	91	126	63
4-Chlorotoluene	15.529	91	126	63
1,3,5-Trimethylbenzene	15.559	105	120	

Table 14				
Characteristic ions				
Compound	Approximate Retention Time (min)	Primary[4]	Secondary	Tertiary
tert-Butylbenzene	16.170	119	91	
1,2,4-Trimethylbenzene	16.278	105	120	
sec-Butylbenzene	16.623	105	134	91
1,3-Dichlorobenzene	16.781	146	148	111
p-Isopropyltoluene	16.939	119	91	134
1,4-Dichlorobenzene	16.958	146	148	111
1,2-Dichlorobenzene	17.688	146	148	111
n-Butylbenzene	17.757	91	92	134
1,2-Dibromo-3-chloropropane (DBCP)	19.255	75	157	155
1,2,4-Trichlorobenzene [2]	20.516	180	182	184
Hexachlorobutadiene	20.773	225	227	223
Naphthalene	20.812	128	51	
1,2,3-Trichlorobenzene [2]	21.108	180	182	184
Hexane				

[1] Primary ion differs from Method 8260B, Table 5.

[2] Confirmation ions differ from Method 8260B, Table 5.

[3] Characteristic ions for this analyte are not listed in Method 8260B, Table 5.

[4] The primary ion should be used for quantitation unless interferences are present, in which case a secondary ion may be used.

[5] m/z 43 may be used for quantitation of 2-Butanone, but m/z 72 must be present for positive identification.

Table 15	
Suggested Instrumental Conditions	
Electron Energy	70 volts (nominal)
Mass Range	35-350 amu
Scan Time	To give at least 5 scans/peak but not to exceed 2 sec/scan
Initial Column Temperature/Hold Time	35°C for 2.0 minutes
Column Temperature Program	35 - 200°C at 15°C/min.
Injector Temperature	220°C
Transfer Line Temperature	150°C
Source Temperature	200°C
GC Carrier Gas	Helium at 37 cm/sec
Purge Gas/Flow	Helium at 40 ml/min
Purge Time/Temperature	11 min at 35°C (Soils) 11 min at 35°C (Waters)
Purging Temperature	35°C
Trap Desorb Time/Temperature	0.5 min at 190 °C
Trap Bake Time/Temperature	7 min at 210 °C

1. SCOPE AND APPLICATTION

1.1. This method describes sample preparation and extraction for the analysis of volatile petroleum hydrocarbons. The procedures used for the petroleum hydrocarbons are based on SW-846, California LUFT, ADEC, and NWTPH methodology. Refer to Table A1 for the individual analytes normally determined by these procedures.

1.2. Compounds within the scope of this method have boiling points below 200°C and are soluble or slightly soluble in water. Classes of compounds best suited to purge-and-trap analysis include low molecular weight halogenated hydrocarbons, aromatics, ketones, nitriles, acetates, acrylates, ethers, and sulfides.

1.3. Water samples and soil samples with low levels of contamination may be analyzed directly by purge-and-trap extraction and gas chromatography. Higher concentrations of these analytes in soil may be determined by the medium level methanol extraction procedure.

2. SUMMARY OF METHOD

Refer to Section 2 of the main body of this SOP for a summary of the method.

3. DEFINITIONS

Refer to Section 3 of the main body of this SOP for a summary of the method.

4. INTERFERENCES

Refer to Section 4 of the main body of this SOP for interferences.

5. SAFETY

Refer to Section 5 of the main body of this SOP for Safety Information.

6. EQUIPMENT AND SUPPLIES

Refer to Section 6 of the main body of this SOP for equipment and supplies.

7. REAGENTS AND STANDARDS

7.1. Refer to Section 7 of the main body of this SOP for reagents and standards as well. The information below is specific to hydrocarbon analysis only.

7.2. Neat Standard Materials

Occasionally, hydrocarbon fuels are not available as stock solutions from commercial vendors. In these instances, neat materials may be acquired directly from the client.

Such neat materials expire following a period of 3 years from the date of receipt, or sooner if problems such as pattern degradation or linearity loss occur.

7.3. Stock Standards

Stock standards are purchased as certified solutions or prepared from pure solutions. Stock standards for petroleum hydrocarbons are stored at -10 to -20°C. Other stock standard solutions are stored at 4 ± 2°C. All stock standards must be protected from light. Stock standard solutions should be brought to room temperature before using.

Stock standards must be replaced at least every 6 months (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Stocks may be replaced sooner if comparison with check standards prepared from an independent source indicates a problem.

7.4. Calibration standards are prepared by injecting a measured volume of the stock standard into a syringe containing the appropriate volume of organic free water. The calibration standard is then loaded into the purge device.

7.5. Gasoline Standards

Due to the differences between fuels available in California (RFG, or Reformulated Gasoline) and those in the rest of the United States, it is recommended that a commercially available composite gasoline standard be used. (Example: XHc Unleaded gasoline composite standard, #30205 from Restek Corp).

8. SAMPLE PRESERVATION AND STORAGE

See Section 8 of the main body of this SOP for information regarding sample preservation and storage. Some state requirements, e.g., ADEC or NWTPH, may require that only field methanol-preserved samples are acceptable.

8.1. If samples are to be analyzed for ADEC, the following preservation is required.

8.1.1. Soil or sediment samples must be collected in appropriately sized containers and submerged in surrogated methanol.

8.1.2. Solid samples must be colleted into tared jars with a Teflon-lined septum fused to the lid. Jars should be 4 oz. or larger if appropriate. 25 mL aliquots of methanol (including 1.2 mL of a surrogate solution of α,α,α,-trifluorotoluene at 50 ug/mL, or equivalent) should be added to the soil until the sample is submerged.

8.1.3. It is extremely important that the weight of the jar, the weight of the methanol/surrogate solution, and the weight of the sample collected be known. These must either be measured directly, or sufficient information documented

so that these weights can be calculated.

8.1.4. Although it is not necessary to refrigerate all methanol preserved samples at 4 ± 2°C after collection and until analysis is complete, the collected samples must be kept below 25°C.

8.1.5. The maximum holding time for soil and sediment samples collected under this Section is 28 days.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the main body of this SOP for general quality control requirements.

9.2. For Method AK 101 prepare and analyze an LCS Duplicate sample as well as an LCS sample for each component of interest (GRO, BTEX) for each analytical batch.

9.3. The surrogate compound for pre-preserved medium level (methanol) soils is a,a,a-triflourotoluene. When this compound is used, the instrument is calibrated with it as well, so that recoveries can be accurately calculated.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to the main body of this SOP for additional calibration information. Note that surrogates are calculated using Method 8260 and specific ion fragments.

10.2. External calibration is used. Prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given Tables A7 and A8.

10.3. Quantitation by the external standard method assumes a proportional relationship between the calibration run and the analyte in the sample. To use this approach, introduce each calibration standard into the GC/MS using the technique that will be used for samples. The ratio of the peak response to the mass or concentration injected may be used to prepare a calibration curve. Peak response is generally measured as the area of the peak.

Equation A 1

$$Calibration\ Factor\ (CF) = \frac{Area\ of\ Peak(s)}{Concentration\ of\ Standard\ (ng/ml\ or\ ug/ml)}$$

10.4. Calibration curve fits

Average response factor, linear regression, or quadratic curves may be used to fit the data. Average response factor may be used if the % RSD of the response factor or

calibration factor of each analyte is ≤ 20%. If an analyte exceeds the criteria, then a regression line (linear or curved) may be attempted.

10.4.1. In general, for environmental analysis, average response factors are the most appropriate calibration model. Linear or curved regression fits should only be used if the analyst has reason to believe that the average RF model does not fit the **normal** concentration/response behavior of the detector.

10.4.2. Average response factor

The average response factor may be used if the average percent relative standard deviation (%RSD) of all the response factors taken together is ≤ 20%. The equation for average response factor is:

Equation A2

$$\text{Average response factor} = \overline{RF} = \frac{\sum_{i=1}^{n} RF_i}{n}$$

Where: n = Number of calibration levels

$\sum_{i=1}^{n} RF_i$ = Sum of response factors for each calibration level

10.4.3. Linear regression

The linear fit uses the following function:

Equation A3

$$x = \frac{(y - b)}{a}$$

Where: y = Instrument response
x = Concentration
a = Slope
b = Intercept

10.4.4. Quadratic curve

The quadratic curve uses the following function:

Equation A4

$$x = \frac{-b + \sqrt{b^2 - 4a(c - y)}}{2a}$$

Where: x = concentration
y = instrument response
a = 2nd order coefficient (curvature)
b = 1st order coefficient (slope)
c = constant (intercept)

10.5. Evaluation of calibration curves

The %RSD from the calibration curve is used to evaluate the initial calibration. If a regression line is used, the coefficient of determination (r2) shall be greater than or equal to 0.990, or the correlation coefficient (r) shall be greater than or equal to 0.995, whichever is appropriate to the regression fit used.

10.6. The following requirements must be met for any calibration to be used:

- Response must increase with increasing concentration.
- If a curve is used, the intercept of the curve at zero response should be less than ± ½ the reporting limit for the analyte.
- The RSD for average response factors for each component must be ≤ 20%.
- When RSD is inappropriate, either the correlation coefficient (r) must be ≥ 0.995, or the coefficient of determination (r^2) must be ≥ 0.990.

10.7. Initial Calibration (ICAL)

10.7.1. Analyze an ICV with the calibration curve. This verification standard is used as a quality control check to verify the accuracy of the calibration.

10.7.2. Low level soil samples must be purged at 50ºC; therefore the calibration curve must also be purged at 50ºC.

10.7.3. A separate calibration, purged at ambient temperature, must be used for aqueous samples. The aqueous calibration may be used for methanolic soil extracts.

10.7.4. Calibrate the instrument using the same volume that will be used during sample analysis.

10.7.5. At the beginning of each initial calibration curve for gasoline or other hydrocarbon fuel mixtures, a carbon range standard is run to determine start and end points for the peak summing range for the mixture.

10.7.5.1. See Table A10 for details of this carbon range standard.

10.7.5.2. See Section 10.13 for setting the peak summing range.

10.7.5.3. As this mixture is used for setting retention times based on the total ion chromatogram, it may be analyzed prior to the BFB required before sample analysis.

10.7.6. Quantitating hydrocarbon mixtures:

Starting and ending retention times for quantitation are determined for each fuel. The peak areas between the starting and ending times are summed and

used to generate a response factor. This factor is used to quantitate sample results, and depending on the client requirements, this factor may be applied to the same retention range as the standard, or to a different range.

10.8. Integration

10.8.1. When evaluating the initial calibration, also evaluate hydrocarbon pattern integration.

10.8.1.1. The integrated peaks should run from the point in the chromatogram prior to peaks to a region following the mixture's peaks in a fairly straight line.

10.8.2. The default integration parameters generated as a result of evaluating the initial calibration should remain in effect until the initial calibration is reanalyzed.

10.9. Initial Calibration Verification (ICV) -- When available, a second source standard is analyzed with the initial calibration curve. Each compound of the second source calibration must be within ± 15% of its expected value, when evaluated with respect to the calibration curve. Corrective actions for the ICV include:

- Rerun the ICV
- Remake or acquire a new ICV
- Evaluate the instrument conditions
- Evaluate the Initial Calibration Standards

10.10. Continuing Calibration Verification (CCV)

10.10.1. Refer to Table A9 for the preparation of CCV standard(s).

10.10.2. The working calibration curve or RF must be verified by the analysis of a mid point calibration standard at the beginning, and at the end of every 12 hour analysis sequence. The mid-level calibration standard used at the start of the analysis must be a different concentration than the mid-level calibration standard used for subsequent calibration verifications. Recommended concentrations are noted in Table A9. Because this standard is evaluated using the total ion chromatogram, rather than specific ion fragments, it may be analyzed after the 12 hours following the BFB tune has expired.

10.10.3. The petroleum hydrocarbon elution profile is compared to the initial calibration to verify that shifting has not occurred since initial calibration. If an alkane range standard has been analyzed, it is checked to verify that shifting has not occurred since the retention time windows for the petroleum hydrocarbon were set.

10.10.4. Any individual compound with %D ≤ 15% meets the calibration criteria.

10.10.5. It is not necessary to run a calibration verification standard at the beginning of the sequence if samples are analyzed immediately after the completion of the initial calibration and second source standard.

10.10.6. If the analyst notes that a CCV has failed and can document the reason for failure (e.g. no purge, broken vial, carryover from the previous sample, etc.) then a second CCV may be analyzed without any adjustments to the instrument. If this CCV meets criteria, then the preceding samples have been successfully bracketed. If adjustments to the instrument are performed before the repeat CCV, then the preceding samples have not been successfully bracketed but analysis may continue.

10.10.7. In general, it is not advisable to analyze repeat CCVs on unattended runs. If repeat CCVs are analyzed, then the first will serve as the bracketing standard for the preceding samples and the last will serve as the CCV for the following samples.

10.10.8. If highly contaminated samples are expected, it is acceptable to analyze blanks or primers at any point in the run.

10.10.9. % Difference is calculated as follows:

Equation A5

$$\%\ Difference = \frac{|\ Expected\ value - Calculated\ value\ |}{Expected\ value} \times 100\%$$

10.10.10. Corrective Actions for Continuing Calibration

If the %D for each analyte of concern is greater than 15%, corrective action must be taken. This may include clipping the column, changing the liner or other minor instrument adjustments, followed by reanalyzing the standard. If the %D still varies by more than + 15%, a new calibration curve must be prepared.

10.10.11. Corrective Action for Samples

Any samples injected after the last good continuing calibration standard must be reinjected, unless one of the following conditions is satisfied:

10.10.11.1. If the CCV response is elevated and the preceding samples are non-detect for all analytes of concern, an NCM may be filed and the data reported.

10.10.11.2. If the samples have already been analyzed twice, and it is apparent that matrix effects are causing the out of control event, an NCM may be filed and the data reported.

10.11. Non-standard analytes are sometimes requested. In the case of these fuels, it may be acceptable to analyze a single standard for pattern identification daily, rather than a five point initial calibration, provided that the QA department and the client agree with this strategy.

10.11.1. Positives which match the pattern of the non-standard analyte may be quantitated based on a standard reference if the elution range is similar and the client agrees to this. In this instance, "unknown hydrocarbons" are quantitated based on the default material for the fraction (e.g., diesel, motor oil, or gasoline, based on elution range).

10.11.2. Otherwise, a five-point initial calibration must be run and samples with positives must be reanalyzed for quantitation. If the analyte is not detected, the non-detect may be reported and no further action is necessary.

10.12. Retention Time Windows

Because multiple peak hydrocarbon mixtures are quantitated based on the total area between two retention times, the retention time windows that are generated are also used to determine the times used for area summing.

Retention time windows must be determined for each hydrocarbon mixture to be analyzed.

10.12.1. Make an injection of the alkane range standards once per day over a three day (72 hour) period. Calculate and tabulate the standard deviation of the three retention times for each peak in the mixture. Plus or minus three times the standard deviation of the retention times of each analyte defines the retention time window.

10.12.2. Hydrocarbon mixture summing windows are the first peak minus three times the standard deviation for that peak to the last peak plus three times the standard deviation for that peak. For example, for a fuel quantitated between n-C10 and n-C24, the peak summing window is from the retention time for n-C10 minus three times the standard deviation for n-C10 to the retention time for n-C24 plus three times the standard deviation for n-C24.

10.12.3. For mixtures which use an alkane which is not present in the carbon range

reference, the retention time of the alkane may be determined by linear extrapolation, and the retention time window of the alkane following the one not present may be used to set peak summing windows. An example of this instance is JP-4 in the extractable hydrocarbons test, which uses n-C13 as the end of the summing window.

10.12.4. Linear Interpolation of Retention Times

Equation A6

$$RT_{Int} = RT_{Earlier} + \frac{(RT_{Later} - RT_{Earlier})}{2}$$

Where: RT_{Int} = Interpolated Retention Time (for n-C13 in the example above)
$RT_{Earlier}$ = Retention Time of earlier peak (for n-C12 in the example above)
RT_{Later} = Retention Time of later peak (for n-C14 in the example above)

10.12.5. The center of the retention time window is the retention time from the last of the three standards. The centers of the windows for the alkane range peaks are updated with the alkane range that is run with new initial calibrations. The widths of the windows will remain the same until new windows are generated following the installation of a new column.

10.12.5.1. Retention time windows for hydrocarbon mixtures are updated at the same time as those for the alkane peaks.

10.12.5.2. If an alkane range is not run with the initial calibration, retention times and summing windows may not be updated.

10.12.6. If the retention time window for an alkane peak calculated above is less than ± 0.03 minutes, use ± 0.03 minutes as the retention time window.

10.12.7. The laboratory must calculate new retention time windows each time a new column is installed. The new windows must be generated within one week of the installation of the new column. Because quantitation of hydrocarbon mixtures is dependent on the peak summing window, calibration data evaluation and sample analysis cannot continue until the alkane retention time windows are established.

10.12.8. Corrective Action for Retention Times

Because quantitation of fuels is based on the total area between two set retention times, each fuel standard's elution profile (peak pattern with respect to retention times denoting start and end of quantitation) in each continuing calibration must be similar to the profile at the time of initial calibration. If this condition is not met, all samples analyzed after the last compliant standard must be reanalyzed.

10.12.8.1. Compare elution profiles by utilizing the data system's capability to overlay chromatograms on-screen, and overlay the mid-level standard from the calibration curve with the daily calibration.

10.12.8.2. Alternatively, compare elution profiles by overlaying hard-copy chromatograms that are at the same scale, and comparing them.

10.12.8.3. Certain methods may require that the alkane standard be run prior to each analytical batch, and that retention times for this standard are evaluated.

Note: *When exaggerated shifting of surrogate compounds occurs in samples, quantitation of any fuel mixture, unknown or otherwise, is likely to be adversely affected. Typically, such retention time shifting will be a result of instrument gas leaks, poor temperature control at the instrument, or poor laboratory temperature control. It is highly recommended that the cause is determined and samples reanalyzed when retention time shifting occurs.*

10.13. Daily Retention Time Windows

The center of the retention time windows determined in Section 11.6 is adjusted to the retention time of each analyte as determined in the CCVs. The retention time windows must be updated at the beginning of each analytical sequence and with each CCV.

11. PROCEDURE

11.1. Refer to Section 11 of the main body of this SOP for information regarding sample preparation and other procedures. Procedures specific to hydrocarbon analysis are presented below.

11.2. Analytical Sequence

11.2.1. Each GC/MS system must be hardware-tuned to meet the abundance criteria listed in Table 15 of the main body of this SOP for a 50 ng injection of BFB (1 uL of a 50ng/uL standard). Analysis must not begin until these criteria are met. These criteria must be met for each twelve-hour time period. The twelve-hour time period begins at the moment of injection of BFB.

11.2.2. After the BFB, the analytical sequence starts with an ICAL of at least five points, or a CCV that meets %D criteria from an existing ICAL.

11.2.3. A CCV must be analyzed at least once every 12 hours when samples are being analyzed, and at the end of the sequence. If there is a break in the analytical sequence of greater than 12 hours, then a new CCV (and BFB) run must be analyzed before proceeding with the sequence.

11.2.4. A CCV consists of mid-level standards for analytes of interest. Elution

profiles of the hydrocarbon mixtures are compared back to the initial calibration to verify the retention ranges.

11.2.4.1. A CCV for Method AK101.0 (State of Alaska) analysis includes analysis of the alkane range standard to verify retention times as well.

11.2.5. After every 20 samples (including QC and instrument blanks), or 12 hours from the time of the opening CCV, whichever is more frequent, a continuing calibration is analyzed. The continuing calibration consists of a mid-level standard differing in concentration from the opening CCV of all petroleum hydrocarbons of interest.

11.3. Low-Level Solids Analysis -- Refer to the main body of this SOP for specifics of low-level solids analysis.

11.3.1. This method may not be used for samples analyzed to support Alaska or Washington State soil investigations.

12. CALCULATIONS/DATA REDUCTION

12.1. Refer to Section 12 of the main body of this SOP for general information regarding data analysis and calculations.

12.2. Qualitative Identification

For fuels (multicomponent analytes), identification occurs when a peak pattern matching the reference standard is found within the elution window for a fuel, at a concentration above the reporting limit, or above the MDL if J flags are required. If the peaks present in the chromatogram elute within the time window of the reference fuel, but the pattern does not match the reference fuel, then the material is determined to be an “Unknown Hydrocarbon” and will be reported accordingly. See the method appendices for further information regarding fuel identification and reporting.

12.2.1. “J” values for Unknown Hydrocarbons

Typically, unknown hydrocarbons are not reported as “J” values, or values below the reporting limit. This is because “Unknown Hydrocarbons” is a category which can both describe fuels too degraded to identify, as well as biologic by-products and other contaminants. Any quantitation of an unknown hydrocarbon is an estimate, as no true reference exists.

12.2.2. The experience of the analyst should weigh heavily in the interpretation of the chromatogram. For example, sample matrix or laboratory temperature fluctuation may result in variation of retention times.

12.2.3. Criteria for determining Gasoline, degraded Gasoline, and Unknown Hydrocarbons:

Presence of BTEX compounds. Native gasoline has a very high BTEX content, and degraded materials typically exhibit this as well. If the sample has been analyzed for BTEX as well as gasoline, the presence and concentration of BTEX relative to the concentration of the hydrocarbon material is a good indicator of gasoline vs. unknown hydrocarbon.

12.2.4. Reporting for ADEC Method AK101.0 (Alaska-GRO)

No "unknown hydrocarbon" is reported for this method. All peak areas between the start of n-C06 and the start of n-C10 are summed. A concentration is calculated, and the results are reported as "Gasoline Range Organics" (GRO).

12.3. Gasoline is quantitated using the area between two marker peaks as specified in Table A2. Because the methanol solvent peak appears in the chromatogram, it is not advisable to sum the entire chromatogram.

12.4. Calculating the "on-column" amount in an unknown sample using Average RRF:

Equation A7

$$C_X = \frac{A_X}{\overline{RF}}$$

Where: A_X = Area of the total ion chromatogram for the compound to be measured
C_X = Concentration of the compound being measured, ng/mL
$\overline{RF}$ = Average response factor of the compound.

12.5. Calculating the "on-column" amount in an unknown sample using a linear fit, not forced through zero. (Based on the "Target" data system).

Equation A8

$$C_X = b + \frac{A_X}{m1}$$

Where: A_X = Area of the total ion chromatogram for the compound to be measured
C_X = Concentration of the compound being measured, ng/mL
b = Constant as calculated by Target
$m1$ = First degree factor, as calculated by Target

12.6. Calculate results in samples as in Section 12 of the main portion of this SOP.

13. METHOD PERFORMANCE

Refer to Section 13 of the main body of this SOP for method performance criteria.

14. POLLUTION CONTROL

Refer to Section 14 of the main body of this SOP for information relating to pollution control.

15. WASTE MANAGEMENT

Refer to Section 15 of the main body of this SOP for information relating to waste management.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III, December 1996, Sections 5000, 5030B, 5035, 8000B, and 8015B.

16.2. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, March 2003, Section 8000C.

16.3. Leaking Underground Fuel Tank Field Manual, State of California, October, 1989

16.4. Underground Storage Tanks Procedures Manual, Alaska Department of Environmental Conservation, December, 10, 1998; Appendix D

16.5. Alaska Department of Environmental Conservation, March 1999; Method AK101.0

16.6. Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997, Method NWTPH-Gx

17. METHOD MODIFICATIONS

17.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the Method Detection Limit. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit.

17.2. This method is performed on a GC/MS, with surrogate values calculated using Method 8260B, and the TPH values calculated using the total area chromatogram. All of the reference methods (CA LUFT, Method 8015B, AK101, and NWTPH-Gx) are based on GC-FID as the detector and the limitations thereof.

17.3. The California LUFT Manual (October, 1989) recommended DHS Analytical Methods indicate that a 3 point calibration is sufficient. However, as many clients default to SW-846, this method defaults to the more stringent SW-846 criterion.

17.4. The California LUFT Manual (October, 1989) recommended DHS Analytical Methods require a 10%D criterion on continuing calibration standard. However, as many clients default to SW-846, this method defaults to the SW-846 criterion. It is believed that

since this lab follows SW-846 criteria, and the DHS method is recommended, the 15%D criteria is sufficient to meet data quality objectives.

17.5. ADEC methodology specifies that semivolatile stock standards expire after 6 months, West Sacramento policy and this SOP state that such standards expire after 1 year.

17.6. ADEC methodology specifies that standards and extracts are stored at –10 to –20°C. This SOP used 4 ± 2°C as the requirement. This temperature range is consistent with other SOPs at this facility.

17.7. NWPTH methodology specifies a linear regression curve fit which is evaluated through the correlation coefficient. This facility defaults to average response factor calibration, and evaluates it through the %RSD. Linear regression curve fits, while permitted in the SOP, are not commonly utilized.

17.8. ADEC methodology specifies a ≤ 25% RSD criterion for evaluating calibration curves. This SOP defaults to the more stringent SW846 criterion of ≤ 20% RSD.

17.9. ADEC methodology specifies a ≤ 25% difference criterion for the 12 hour calibration. This SOP defaults to the more stringent SW846 criterion of ≤ 15% difference.

17.10. Purge volumes greater than 5 mL (up to 25 mL) may be used as required to meet reporting limits.

17.11. The shutoff valve for the sample-measuring syringe has been omitted.

17.12. The use of a soil aliquot between 1 g and 5 g is allowed if performance criteria are met.

17.13. The method has been extended to include the use of VOA vial sampling purge and trap autosamplers.

17.14. A composite gasoline standard available from an outside vendor is recommended, rather than the gasoline composite mixtures cited in the reference methods for NWTPH-Gx.

17.15. To comply with the NWTPH-Gx (State of Washington) methodology, a correction factor must be applied to compensate for the mass of oxygenated components present in any oxygenated fuels used for the composite. Contact the vendor to obtain this value.

17.16. Method 5035 states that calibration standards for low-level solids preserved with sodium bisulfate should also have sodium bisulfate present, at approximately the same levels, in order to compensate for the effects of the preservative on analyte purgeability. At this time, West Sacramento does not use different calibration curves

for solids preserved with sodium bisulfate. All solid calibration curves omit the sodium bisulfate.

17.17. Modified purge temperature in Section 10.7.2 from 40°C to 50°C

18. ATTACHMENTS

18.1. Table A1 – Standard Analyte List

18.2. Table A2 – Volatile Petroleum Hydrocarbon Quantitation Ranges.

18.3. Table A3 – Composition and Concentration of Standard Solutions

18.4. Table A4 – LCS/MS/SD Concentrations for Aqueous Samples

18.5. Table A5 – LCS/MS/SD Concentrations for Low-Level Solid Samples

18.6. Table A6 – LCS/MS/SD Concentrations for Medium-Level Solid Samples

18.7. Table A7 – Aqueous and Medium-Level Solid Calibration Standard Concentrations (ug/L)

18.8. Table A8 – Low-Level Solid Calibration Standard Concentrations (ug/kg)

18.9. Table A9 – Calibration Standard Recipes (ICAL and CCV Standards)

18.10. Table A10 – Alkane Range Standard (5 uL spiked into 5 mL)

18.11. Table A11 – Initial Demonstration Limits

18.12. Table A12 – AK101 Recovery Requirements

Table A1				
Standard Analyte List				
Compound	CAS Number	Reporting Limit, ug/L or ug/kg		
		Aqueous	Low Soil	Medium Soil
Gasoline	39-40-0	50	500	5000
Gasoline Range Organics (GRO)	NA	50	500	5000

Table A2		
Volatile Petroleum Hydrocarbon Quantitation Ranges.		
Regulatory Method	Quantitation Range	
	Start	End
Method 8015B	2-methylpentane	1,2,4-Trimethylbenzene
CA-LUFT	n-C07	n-C12
NWTPH-Gx[1]	toluene	naphthalene
AK101.0[2]	n-C06	n-C10

[1] *The method specifies that the peak summing window must include the specified peaks at a minimum. The range may extend before toluene and after naphthalene if that seems reasonable after examining the fuel pattern.*

[2] *The method specifies that the peak summing window must start at the start of the n-C06 peak and end at the start of the n-C10 peak.*

Table A3 Composition and Concentration of Standard Solutions		
Components	Low-Level Working Solution Concentration, ug/mL	Medium-Level Working Solution Concentration, ug/mL
Gasoline	1000	50000

Note: "Low-Level" working solution is used for aqueous, low-level solid, and calibration standard spiking. The "Medium-Level" working solution is used for spiking medium-level samples and samples preserved with methanol.
Refer to the main body of this SOP for surrogate details.

Table A4 LCS/MS/SD Concentrations for Aqueous Samples			
Low-Level Solution	Working Solution ug/mL	Spike amount uL (into VOA vial)	Final concentration ug/L
Gasoline	1000	21.5	500

Refer to the main body of this SOP for surrogate details.

Table A5 LCS/MS/SD Concentrations for Low-Level Solid Samples			
Low-Level Solution	Working Solution ug/mL	Spike amount uL (onto 5g solid with 10 mL water)	Final concentration ug/kg
Gasoline	1000	5.0	1000

Refer to the main body of this SOP for surrogate details.

Table A6 LCS/MS/SD Concentrations for Medium-Level Solid Samples			
Medium-Level Solution	Working Solution ug/mL	Spike amount uL (onto 5g solid with 5 mL MeOH)	Final concentration Ug/kg
Gasoline	50,000	5.0	50,000

Refer to the main body of this SOP for surrogate details.

Table A7								
Aqueous and Medium-Level Solid Calibration Standard Concentrations (ug/L)								
Component	1	2	3	4	5	6	7	8
Gasoline (Aq)	50	100	500[1]	1,000	2,500	5,000	7,500	10,000
Gasoline (Soi)	50	100	500	1,000	2,500	5,000	10,000	25,000

[1] *Designates the mid-level standard concentration used for the ICV and CCVs following the initial CCV of a sequence.*

Refer to the main body of this SOP for surrogate details.

Table A8								
Low-Level Solid Calibration Standard Concentrations (ug/kg)								
Component	1	2	3	4	5	6	7	8
Gasoline	50	100	500[1]	1000	2500	5000	7500	--

[1] *Designates the mid-level standard concentration used for the ICV and CCVs following the initial CCV of a sequence.*

Refer to the main body of this SOP for surrogate details.

Table A9									
Calibration Standard Recipes (ICAL and CCV Standards)									
Component	Solution Conc. ug/mL	1	2	3	4	5	6	7	8
Aqueous and Medium-Level Solid Samples (uL, Spiked into 100 mL)									
Gasoline	1000	25[1]	50[1]	25[2]	50	125	250	375	--
Low-level Solid Samples (uL, Spiked into 100 mL, 10 ml is 5g equivalent)									
Gasoline	1000	2.5[1]	5.0[1]	2.5[2]	5.0	12.5	25.0	37.5	--

[1] *The Gasoline standard is a 1:10 dilution of the working 1000ug/mL standard*

[2] *This is the recipe for the CCV standard as well.*

Refer to the main body of this SOP for surrogate details.

Table A10		
Alkane Range Standard (5 uL spiked into 5 mL)		
Components	Working Solution ug/mL	Final Concentration ug/L
n-C06 (hexane)	10	10
n-C07 (heptane)	10	10
2-Methylpentane	10	10
n-C10 (decane)	10	10
n-C12 (dodecane)	10	10
Naphthalene	10	10
1,2,4-Trimethylbenzene	10	10

Table A11		
Initial Demonstration Limits		
Analyte	Initial Demonstration Recovery Limits, %	Initial Demonstration RSD Limits, %
Gasoline	70-130	25
Additional Fuels	70-130	25

Table A12	
AK101 Recovery Requirements	
Requirement	Criteria
Surrogate recovery in samples	50-150%
Surrogate recovery in CCV, LCS/D	60-120%
LCS Recovery	60-120%
LCS/LCSD RPD	less than or equal to 20%

Title: Inductively Couple Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analyses, SW-846 Method 6010B
[Method 6010B]

Approvals (Signature/Date):

Robert Hrabak 11/9/11 Technical Manager	Joe Schairer 11/9/2011 Health & Safety Manager / Coordinator
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1. SCOPE AND APPLICATION

1.1. This method is applicable to the determination of trace metals by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) using EPA Method 6010B.

1.2. Table 2 lists elements currently approved under NELAC standards for analysis by methods 6010B. Additional elements may be analyzed under Methods 6010B provided that the method performance criteria presented in Section 13 are met.

1.3. ICP analysis provides for the determination of metal concentrations over several orders of magnitude. See Table 2 for Reporting Limits (RLs).

1.4. Methods 6010B is applicable to the determination of dissolved, suspended, total recoverable and total elements in ground water, aqueous samples, soils, sludges, wastes, sediments, tissues, biological materials, and TCLP, STLC, and SPLP leachates/extracts. All matrices require digestion prior to analysis with the exception of STLC extracts, and samples for dissolved metals. Although digestion is not specifically required by the method, some clients and regulators may require digestion of dissolved samples and this must be clarified and documented before project initiation. Silver concentrations must be below 2.0 mg/L in aqueous samples and 100 mg/kg in solid matrix samples. Precipitation may occur in samples where silver concentrations exceed these levels and lead to the generation of erroneous data. In addition, digested samples that contain tin at concentrations greater than 1% should be prepared again using <1 g of sample weight.

1.5. This SOP is not applicable for the analysis of drinking waters.

1.6. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. This method describes multi-elemental determinations by ICP-AES using a simultaneous optical system with axial and radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are introduced via a nebulizer and the aerosol that is produced is transported to the plasma torch where excitation occurs. Emission specific spectra are produced by radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are measured by a charge-coupled device (CCD) detector(s). The photocurrents from the CCDs are processed and controlled by a computer system.

2.2. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interferences and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result.

2.3. The possibility of additional interferences should also be recognized and appropriate actions taken. Alternatively, multivariate calibration methods may be chosen for which point selection for background correction is superfluous since whole spectral regions are processed.

2.4. Refer to the appropriate SOPs for details on sample preparation methods.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Spectral, physical and chemical interference effects may contribute to inaccuracies in the determinations of trace elements by ICP.

4.2. Spectral interferences are caused by several causes.

4.2.1. Overlap of a spectral line from another element.

4.2.2. Unresolved overlap of molecular band spectra.

4.2.3. Background contribution from continuous or recombination phenomena.

4.2.4. Stray light from the line emission of high concentration elements.

4.3. These interferences in Section 4.2 should be measured and evaluated after scans of analyte wavelengths and their adjacent sides have been performed.

4.4. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background correction is not

required in cases where a background corrective measurement would actually degrade the analytical result.

4.5. Inter-element correction factors (IECs) or other instrument correction routines are necessary to compensate for spectral overlap. Inter-element interferences occur when elements in the sample emit radiation at wavelengths so close to that of the analyte that they contribute significant intensity to the analyte channel. If such conditions exist, the intensity contributed by the matrix elements will cause an excessively high (or sometimes low) concentration to be reported for the analyte. Inter-element correction factors must be applied to the analyte to remove the effects of these unwanted emissions. The Perkin Elmer Optima instrument can use Multicomponent Spectral Fitting (MSF) which also corrects for spectral interference by measurement of both the interferents and the matrix background contribution.

4.6. Physical interferences are generally considered to be effects associated with sample transport and conversion within the plasma. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension) or during excitation and ionization processes within the plasma itself. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high total dissolved solids (TDS) or high acid concentrations. If physical interferences are present, use of an argon humidifier, peristaltic pump, mass flow controller, internal standardization, and/or a high solids nebulizer can reduce the effect.

4.7. Chemical interferences are characterized by molecular compound formation, ionization effects and solute vaporization effects. Normally these effects are not significant with the ICP technique, but if observed can be minimized by buffering the sample, matrix matching, or standard addition procedures.

4.8. Memory interferences result when analytes from a previous sample carryover into a new sample. Theses interferences occur from sample buildup onto and release from sample introduction components such as the autosampler sipper, nebulizer, sample capillaries, spray chamber, plasma injector, and torch. The memory effect is element and matrix dependent. It may result from the analysis of high analyte concentrations or the uptake and action of non-target matrix compounds. Analysts should recognize memory effects and re-analyze samples when necessary.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate

safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex, vinyl and nitrile gloves all provide satisfactory protection. Additional PPE (personal protective equipment) such as goggles or a face shield and apron are required when transferring instrument waste containers.

5.1.2. Exposure to chemicals must be maintained as low as reasonably achievable; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.3. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.4. This instrument produces RF energy. People with pacemakers should not go near the instrument while it is in operation.

5.1.5. The ICP plasma emits strong UV light and is harmful to vision. Anyone around the instrument must avoid looking directly at the unshielded plasma.

5.1.6. Some extractions and digestions use hydrofluoric acid, which means that some samples to be analyzed are in an HF solution. The labels for all such extracts and digestates will be highlighted in yellow. The use of hydrofluoric acid requires special safety precautions. Consult the facility EH&S staff and the local supplement to the Corporate Safety Manual for guidance. Anyone working with HF must receive special training before starting work. Staff members who work around HF should also receive this training. HF acid solutions may not be used for any purposes except as prescribed in this or other SOPs for this laboratory. Processes involving HF acid are classified as high-risk activities. Personnel involved must wear a face shield in addition to safety glasses or goggles.

WARNING: The laboratory's Emergency Response Team must be activated for any suspected exposure to HF liquid or fumes. After local emergency response, the victim will be transported to the UCD Medical Center Emergency Room.

Appendix 4 is a detailed first aid plan for working with HF.

5.1.6.1. 2.5% calcium gluconate gel should be applied copiously and gently massaged into burn sites after rinsing under cold running water for one minute to remove HF acid from the surface of the skin. The person massaging should wear appropriate protective gloves. If the victim is conscious, they should consume small quantities of calcium or magnesium containing liquids, such as milk, Maalox, or Mylanta. If the burn site is too large to massage with calcium gluconate gel, cover it with gauze soaked in an Epsom salt solution (1 cup to 1 quart of cold water). Keep the wraps saturated with the Epsom salt solution.

5.1.6.2. Some metals react with HF to produce flammable hydrogen gas.

5.1.6.3. Glass reacts with HF to produce toxic silicon tetraflouride.

5.1.6.4. HF is classified as a poison, and must be stored in a locked cabinet when not in use.

5.1.6.5. Whenever HF is in use in a laboratory, a decontamination solution will be prepared before starting work. Take a small bucket (2-3 gallons) and fill it about 2/3-3/4 full with an Epsom salts solution. Before removing gloves or handling anything else that HF on the gloves might be transferred to, carefully dip one hand at a time into the Epsom salts solution for a few seconds. Do not put the hand any deeper than necessary to bring the solution level to within 1-2 inches of the glove cuff. The Epsom salts solution will be prepared each day prior to beginning work with HF, and disposed at the end of the day down the laboratory sink.

5.2. Primary Material Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid (1)	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid (1)	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrofluoric Acid (1)	Poison Corrosive Dehydrator	3 PPM - TWA	Corrosive to the skin and eyes. Contact causes serious skin burns, which may not be immediately apparent or painful. Symptoms may be delayed 8 hours or longer. Severely corrosive to the respiratory tract. Permanent eye damage may occur. **THE FLUORIDE ION READILY PENETRATES THE SKIN CAUSING DESTRUCTION OF DEEP TISSUE LAYERS AND BONE DAMAGE.**
Triton X-100 (alkyl aryl polyether alcohol)	Irritant	1 PPM – TWA 5 PPM – STEL	Irritates the respiratory tract, causes coughing and shortness of breath. Can cause severe eye irritation with inflammation, swelling and chemical burns to cornea.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. A Thermo 6500 Duo ICP utilizing iTEVA version 2.4.0.8 software, with radio frequency generator, and computer controlled pneumatic mass flow controllers and multi-channel peristaltic pump. A concentric nebulizer and cyclonic spray chamber are included in the sample introduction system.

6.2. Argon gas supply, welding grade or equivalent.

6.3. Nitrogen gas.

6.4. Compressed air.

6.5. Water re-circulator / chiller.

6.6. Adjustable air displacement pipettes.

6.7. Class A glass volumetric pipettes.

6.8. Class A volumetric flasks.

6.9. Autosampler tubes, 13 x 100 mm polystyrene or polypropylene.

7. REAGENTS AND STANDARDS

7.1. Use reagent grade chemicals in all tests. "Certificates of Analysis" should be supplied with all chemicals purchased. If not supplied, contact the vendor. When received, label the certificate and the reagent container with the receipt date. Reagent containers also need to be labeled with the opened and expiration dates.

7.2. Reagent water is produced by a Millipore nanopure system. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.3. Concentrated nitric acid (HNO_3), trace metal grade or better.

7.4. Concentrated hydrochloric acid (HCl), trace metal grade or better.

7.5. Instrument rinse: Add 2000 mL of reagent water to the 4000 mL rinse container. Add 40 mL of concentrated HNO_3 and 200 mL of concentrated HCl and dilute to volume with reagent water.

7.6. Dilution Solution: Add 800 mL of reagent water to the 1000 mL dilution container. Add 10 mL of concentrated HNO_3 and 50 mL of HCl and dilute to volume with reagent water.

7.7. Stock standards are purchased as custom multi-element mixes and as single-element solutions. These must be plasma grade standards.

7.7.1. All standards must be stored in FEP fluorocarbon or unused polyethylene or polypropylene bottles.

7.7.2. Standards containing silver must be protected from light. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer.

7.7.3. If no expiration date is provided, the stock solutions may be used for up to one year from opening and must be replaced sooner if verification from an independent source indicates a problem.

7.8. The PQLCRI intermediate standard (LL1) is made completely from 1000 mg/L or 10,000 mg/L single source stock standards. Add 50 mL reagent water and 2.0 mL HNO_3 to a 100 mL volumetric flask. Table 7 shows the spiking levels of each stock used to make the PQLCRI intermediate standard (LL1). Each is spiked with the appropriate sized adjustable air displacement pipette. Dilute to volume with reagent water. The intermediate standard expires 6 months after it is made.

7.9. Linear Range Standard (LRS): Add 50 ml of reagent water to a 100 mL volumetric flask. Add 5.0 mL of concentrated HCl and 1.0 mL of concentrated HNO_3. Add mixed and single source standards as defined by Table 11. Dilute to volume with reagent water. The LRS expires 6 months after it is made.

7.10. Triton X-100 (alkyl aryl polyether alcohol).

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding times for metals are six months from time of collection to the time of analysis.

8.2. Aqueous samples are preserved with nitric acid to a pH of <2 and may be stored in either plastic or glass. If boron or silica is to be determined, plastic containers are preferred. Refrigeration is not required. Preservation must be verified prior to analysis.

8.3. Soil samples do not require preservation but must be stored at 4 ± 2°C until the time of preparation.

9. QUALITY CONTROL

9.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A batch must be prepared within the same time frame. A method blank (MB) and a laboratory control sample (LCS) or duplicate control sample (LCS/LCSD) must be prepared as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/MSD), or in some instances a sample/sample duplicate. An analytical batch must include all QC samples, however they do not contribute to the maximum of 20 samples. Refer to the Quality Program document (WS-PQA-0003) for more details.

9.2. One method blank (MB) must be prepared for every 20 samples. A method blank consists of reagent water processed through all of the steps, and at the same time as the associated samples. If a method blank exceeds ± the reporting limit for a given analyte than the samples associated with that batch must be re-prepared. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo. For samples requiring laboratory filtration and preservation, the method blank must also be filtered and preserved. Refer to the Quality Program document (WS-PQA-0003) for more details.

9.2.1. For samples analyzed under QSM Version 3, QSM Version 4.2, and AFCEE Version 4.0, the results of the method blank must be ½ the RL for a given

analyte. The same exceptions apply as stated above.

9.3. A laboratory control sample (LCS) must be prepared for every 20 samples. A LCS consists of reagent water spiked with the analytes of interest and processed through all of the steps, and at the same time as the associated samples. If a LCS is outside of percent recovery acceptance criteria, all of the samples associated with that LCS must be re-prepared except when a LCS exhibits high recovery. For such a case, those samples with analyte concentrations less than the reporting limit can be reported. All corrective actions must be documented on a Non-conformance memo. Refer to the Quality Program document (WS-PQA-0003) for more details.

9.3.1. For samples analyzed under QSM Version 3, QSM Version 4.2, and AFCEE Version 4.0, there is no exception for reporting "ND" samples for a high LCS.

9.3.2. Random marginal exceedances: For analyte lists of 11-30 elements, 1 LCS random marginal exceedance is allowed. In this case the LCS must be within 4 standard deviations of the mean, and control charts must be evaluated to assure that the marginal exceedence is random, as defined in Policy WS-PQA-0003.

9.4. A Matrix Spike/Matrix Spike Duplicate (MS/MSD) pair must be prepared with every process batch of similar matrix, not to exceed twenty (20) samples. MS/MSD pairs are aliquots of a selected field sample spiked with all of the analytes of interest at known concentrations. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside control limits must be within control limits in the LCS. Re-extraction of the blank, LCS, selected field samples, and the MS/MSD may be required after evaluation and review of the MS/MSD results.

9.5. A duplicate control sample (LCS/LCSD) may be substituted when insufficient volume is provided to process a sample/sample duplicate or MS/MSD pair, and batch precision is required by the client or program. The LCS and LCSD are evaluated independently for acceptance. Refer to the Quality Program document (WS-PQA-0003) for more details.

9.5.1. Samples identified as field blanks, equipment blanks, or trip blanks should not be used for MS/MSD analysis.

9.6. Initial Calibration Verification (ICV/ICB) – Calibration accuracy is verified by analyzing a second source standard (initial calibration verification standard) immediately upon completion of instrument calibration. This standard must be at a concentration different from that used to calibrate the instrument and different from the CCV standard. The ICV must fall within ± 10% of the true value of the standard solution for method 6010B. An ICB (initial calibration blank) prepared the same as the calibration blank must be analyzed immediately following the ICV to monitor low

level accuracy and system cleanliness. The ICB result must fall within ± the reporting limit from zero. If either the ICV or ICB fail to meet acceptance criteria the analysis must be terminated, the problem corrected, and the instrument re-calibrated.

9.6.1. For all ICVs and CCVs, the RSD between the two replicates run for each sample must be less than 5%. If this fails for any analyte, rerun the QC and all the samples affected by the out of control event.

9.6.2. For QSM Version 3, QSM Version 4.2, and AFCEE Version 4.0, the ICB and CCB results for all analytes must be less than 2X the MDL.

9.7. Continuing Calibration Verification (CCV/CCB) - Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard (continuing calibration standard) after every 10 samples. Ten samples include any analysis that registers with a result, even if not used. The CCV must be a mid-range standard at a concentration other than that of the ICV. The CCV result must fall within ±10% of the true value for that solution for method 6010B. A CCB (continuing calibration blank) is analyzed immediately following each CCV. The CCB result must fall within ± RL from zero. Each CCV and CCB analyzed must reflect the conditions of analysis of all associated samples. Sample results may only be reported when bracketed by valid ICV/CCV and ICB/CCB pairs. If a mid-run CCV or CCB fails, the possible cause of failure should be investigated, and all samples analyzed since the last acceptable CCV and or CCB must be reanalyzed.

9.8. PQLCRI Standard (LL1): Following analysis of the ICV/ICB pair the PQLCRI standard (LL1) is analyzed spiked with concentrations of each analyte of interest at or sometimes below the reporting limit. The percent recovery of the PQLCRI standard (LL1) results must be ± 50% of the true concentration. If the recovery is out of control, rerun the standard once. I f still outside of control limits, terminate the analysis, resolve the problem, and re-calibrate the instrument.

9.8.1. Since reporting limits may vary for some programs requiring a PQLCRI standard (LL1), the analyst may need to make up different concentrations.

9.8.2. For QSM Version 3, QSM Version 4.2, and AFCEE 4.0, the PQLCRI standard (LL1) criterion is ± 20%.

9.9. Dilution test (Serial Dilution) – A dilution test is performed to determine whether significant physical or chemical interferences exist due to the sample matrix. One sample per preparation batch must be processed as a dilution test. The test is performed by running a sample at a 5X (1+4) dilution. Samples identified as field blanks cannot be used for dilution tests. The results of the diluted sample, after correction for dilution, should agree within 10% of the original sample determination when the original sample concentration is greater than 50X the IDL. If the results are not within 10%, the possibility of chemical or physical interference exists.

9.9.1. For QSM Version 3 and QSM Version 4.2 the criterion for evaluating serial dilution results is when the sample concentration is greater than 50X the MDL. Samples that fail the serial dilution must then be evaluated using a post-digestion spike.

9.10. Post-digestion spikes: One sample in every batch must be spiked with all of the elements of interest at the instrument following sample preparation. The matrix spiking solution is generally used as the post-digestion spike at the same concentrations as the matrix spikes.

9.10.1. If the recovery of the post-digestion spike for an element is outside of 75-125%, a matrix effect should be suspected when the spike level is greater than 25% the concentration of the analyte in the sample.

9.10.2. No MSAs are required as long as an internal standard is being used for all analyses.

9.11. Interference Check Analysis (ICSA/ICSAB) – The validity of the interelement correction factors is demonstrated through the successful analysis of interference check solutions. The ICSA contains only interfering elements, the ICSAB contains analytes and interferents. All analytes should be spiked into the ICSAB solution; therefore, if a non-routine analyte is required then it should be manually spiked into the ICSAB using a certified ultra high purity single element solution or custom mix. If the ICP will display over-correction as a negative number then the non-routine elements can be controlled from the ICSA as described below. Elements known to be interferents on a required analyte must be included in the ICP run when that analyte is determined. Aluminum, iron, calcium and magnesium must always be included in all ICP runs.

9.11.1. The ICSAB results for the interferents must fall within 80 – 120% of the true value. If any ICSAB interferent result fails criteria, the analysis should be terminated, the problem corrected, the instrument recalibrated and the samples rerun.

9.11.2. ICSA results for the non-interfering elements must fall within ± 2X the reporting limit from zero. If the ICSA results for the non-interfering elements do not fall within ± 2X RL from zero the field sample data must be evaluated. For QSM Version 3 and QSM Version 4.2, the ICSA result cannot be greater than 2X the MDL unless an analyte is confirmed as being a contaminant in the spiking solution.

9.11.2.1. If the non-interfering element concentration in the ICSA is the result of contamination versus a spectral interference, and this reason is documented, the field sample data can be accepted.

9.11.2.2. If the affected element was not required then the sample data can be accepted.

9.11.2.3. If the interfering elements are not present in the field sample at a concentration that would result in a false positive or negative result greater than ± 2x RL from zero, then the field sample data can be accepted.

9.11.2.4. If the interfering element is present in the field sample at a level which would result in a false analyte signal greater than ± 2x RL from zero, the data can be accepted only if the concentration of the affected analyte in the field sample is more than 10x the analyte signal in the ICSA. The interference must be within the linear range, or the sample must be diluted.

9.11.2.5. If the data does not meet the above conditions then the IECs must be re-evaluated and corrected if necessary and the affected samples reanalyzed or the sample results manually corrected through application of the new IEC to the raw results. If the results are recalculated manually the calculations must be clearly documented on the raw data.

9.12. For QSM Version 3, QSM Version 4.2, and AFCEE Version 4.0, a linear range standard (LR) is analyzed after the completion of calibration. The linear range standard contains analytes at high levels such that no sample concentration exceeds these levels. If sample concentrations exceed that of the linear range standard for any given analyte, the sample requires dilution at a concentration less than that in the linear range standard. This standard differs from the linear dynamic range standard defined in Section 10.4.

10. CALIBRATION

10.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 “Calibration Curves (General)”.

10.2. Background Correction Points – To determine the appropriate location for off-line background correction when establishing methods, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Background correction points must be set prior to determining IECs. Alternatively,

users may choose multivariate calibration methods. In this case, background correction points are superfluous since whole spectral regions are processed. MSF is not used for method 6010 analyses at this laboratory.

10.3. Inter-element Corrections (IECs) – ICP interelement correction factors must be determined prior to the analysis of samples and every six months thereafter.

10.3.1. If the instrument is adjusted in any way that may affect the IECs, the IECs must be re-determined.

10.3.2. When initially determining IECs for an instrument, wavelength scans must be performed to ensure that solutions in use are free from contaminants. If an IEC varies significantly from the previously determined IEC then the possibility of contamination should be investigated. The purity of the IEC check solution can be verified by confirming results against a certificate of analysis (COA), using a standard from a second source, or by an alternate analytical method (i.e., GFAA or ICP-MS). Published wavelength tables (e.g. MIT tables, Inductively Coupled Plasma-Atomic Spectroscopy: Prominent Lines) can also be consulted to evaluate the validity of the IECs.

10.3.3. Refer to the instrument manufacturer's recommendations for specific procedures to be used in setting IECs. An IEC must be established to compensate for any interelement interference resulting in a false analyte signal greater than ± the RL (Table 1).

10.3.4. To determine IECs, run a single element standard at the established linear range. To calculate an IEC, divide the observed concentration of the analyte by the observed concentration of the "interfering element."

10.3.5. Trace ICP IECs are more sensitive to small changes in the plasma and instrument setup conditions. Adjustments in the IECs will be required on a more frequent basis for the trace ICP as reflected by the ICSA response. Single element solutions of aluminum, calcium, iron, magnesium, and other interferents may be analyzed routinely to verify IEC factors on target analytes such as arsenic, lead, selenium, and thallium.

10.3.6. Spectral overlap may be avoided by using an alternative wavelength when available. Refer to the ICP instrument manual for specific procedures to use multivariate calibrations.

10.4. Linear Dynamic Range Verification (LDR) – The linear dynamic range must be determined every six months for each analyte wavelength used on each instrument. The linear dynamic range is the concentration above which results cannot be reported without dilution of the sample. The standards used to define the linear dynamic range limit must be analyzed during a routine analytical run. For the initial determination of

the upper limit of the linear dynamic range (LDR) for each wavelength, determine the signal responses from a minimum of three to five different concentration standards across the estimated range. One standard should be near the upper limit of the estimated range. The concentration measured at the LDR must be no more than 10% less than the expected level extrapolated from lower standards. If the instrument is adjusted in any way that may affect the LDRs, new dynamic ranges must be determined. The LDR data must be documented and kept on file.

10.5. Rinse Time Determination – Rinse times must be determined annually. To determine the appropriate rinse time for a particular ICP system, the linear range verification standard (see Section 10.4) should be aspirated as a regular sample followed by the analysis of a series of rinse blanks. The length of time required to reduce the analyte signals to < RL will define the rinse time for a particular ICP system. For some analytes it may be impractical to set the rinse time based on the linear range standard result (i.e., analyte not typically detected in environmental samples at that level and an excessive rinse time would be required at the linear range level). A rinse period of at least 60 seconds between samples and standards is recommended. If a memory effect is suspected, the sample must be reanalyzed after a rinse period of sufficient length. Rinse time studies can be conducted at additional concentration levels. These additional studies must be documented and kept on file if a concentration other than the linear range level is used to set the rinse time. The concentration levels used to establish the rinse time must be taken into consideration when reviewing the data.

10.6. Calibration must be performed daily and each time the instrument is set up. The calibration curve must consist of a minimum of a blank and a standard. Calibration must be in accordance with the instrument manufacturer's procedure. Flush the system with the calibration blank between each standard or as the manufacturer recommends. Refer to the specific ICP instrument manual for detailed set up and operation protocols.

10.6.1. Tables 2-5 show the concentration of each calibration standard. All standards are made in 5% HCl and 1% HNO_3 solution. Most of the elements are calibrated using a blank and a single standard. A multipoint calibration of 2 or 3 points may be required on some elements to improve linearity at the lower and upper limits of the range. If multiple levels are used, the r-value must be ≥ 0.995. Elements may be separated into different calibration standards due to compatibility issues of the various vendor mixtures.

10.6.2. Working calibration and calibration verification solutions may be used for up to 6 months and must be replaced sooner if verification from an independent source indicates a problem.

10.7. Analysis of the initial calibration verification standards (ICV) immediately follows calibration of the instrument unless a linear range standard is being analyzed per QSM criteria. Stock second source standards for preparation of the initial calibration verification standards are a combination of custom multi-element mixes and single

element solutions. Each must be from a different vendor than those standards supplied for the calibration standards. If from the same vendor, they must be supplied with a separate Lot ID. Tables 7 and 8 show the concentrations of stock solutions used to make the ICV working standard. All standards are made in 5% HCl / 1% HNO_3.

10.7.1. The ICV standard may be used for up to 6 months and must be replaced sooner if verification from an independent source indicates a problem.

10.8. PQLCRI Standard (LL1): A standard made at the concentration of, or in some cases below, the reporting limit for all analytes in the method must be analyzed after the ICV/ICB. For the working PQLCRI (LL1), add 50 mL of reagent water, 5 mL of HCl, and 1 mL of HNO_3 to a 100 mL volumetric flask. Spike this with 1.0 mL of the intermediate PQLCRI standard (LL1) and dilute to volume with reagent water.

10.8.1. The PQLCRI standard (LL1) may be used for up to 7 days.

10.8.2. For QSM work, as separate QSMPQL (LL2) standard is made at slightly higher reporting limit.

10.9. Analysis of the ICSA follows the PQLCRI standard (LL1). To make the ICSA standard, add 300 mL of reagent water to a 500 mL volumetric flask. Add 25 mL of concentrated HCl and 5 mL of concentrated HNO_3. Add 50 mL of Inorganic Ventures mixed standard CLPP-ICS-A and dilute to volume. See Table 10A for ICSA standard concentrations.

10.10. ICSAB analysis directly follows that of ICSA. ICSAB is made by adding 300 mL of reagent water to a 500 mL flask. Add 25 mL of concentrated HCl and 5 mL of concentrated HNO_3. Add 50 mL of Inorganic Ventures mixed standard CLPP-ICS-A and 5.0 mL of Inorganic Ventures CLPP-ICS-B4. The final concentrations are those defined by Tables 10A and 10B.

10.10.1. ICSA and ICSAB may be made every six months and must be replaced sooner if verification from an independent source indicates a problem.

10.10.2. Some regulatory criteria may require that ICSA and ICSAB be analyzed routinely throughout and analytical run or at the beginning and end of the run.

10.11. Instrument runs may be continued over periods exceeding 24 hours as long as all calibration verification (CCV) and interference check QC criteria are met. The instrument standardization date and time must be included in the raw data.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. All samples require a preparation prior to analysis depending on the matrix being evaluated. Preparation of each batch requires a method blank, LCS, and matrix spikes and/or matrix spike duplicates. The concentration of analytes in the LCSs and matrix spikes are listed in the individual preparation methods.

11.2.1. For method 6010B soils analysis, EPA method 3050B is used to prepare all samples.

11.2.2. For method 6010B aqueous samples, samples are primarily prepared using the total digestion procedure method 3010A, although some clients request total recoverable metals.

11.2.3. For many method 6010B dissolved samples, we use a matrix matching procedures defined under SOP WS-IP-0008.

11.3. Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (approximately 30-60 minutes of warm-up is suggested).

11.4. Profile and/or align the instrument in accordance to the instrument manufacturer's recommended procedures.

11.5. Rinse the instrument with the calibration blank to flush the system. Verify internal standard(s) will be added to standards and samples by the instrument.

11.6. A minimum of two exposures for each standard, field sample and QC sample is required. The average of the exposures is reported.

11.6.1. To support some client-specific programs, it may be necessary to evaluate the relative standard deviation of exposures for field samples. If this is necessary, the criteria will be ≤ 20% or [±RL] if the RL for that element is 5 µg/L or less and the detected concentration is less than twice the RL.

11.7. Before setting up an analytical run, read the QAS for all of the lots being analyzed. The QAS is created by the project managers and defines any special criteria required for client specific analyses.

11.8. Calibrate the instrument according to the guidelines in Section 10.6.

11.9. Analyze a LR (linear range) standard for DOD QSM. Target analytes must be within ± 10% of the true value to be acceptable. The concentration of each analyte in the linear range standard is defined in Table 12.

11.10. Analyze ICVs/ICB after the calibration sequence. Section 9.6 defines the acceptance criteria for ICVs/ICB analysis for all method referenced in this document. The concentrations of the ICVs are defined in Tables 7 and 8.

11.11. Analyze a low-level standard(s) at or below the RL (PQL standard) if required by client specific. Follow QAPP acceptance criteria, or ± 50% of true value. For QSM Version 3 and QSM Version 4.2, the acceptance criterion is ± 20% of true value, but the reporting limits differ and therefore the concentrations of analytes in the QSM PQL (LL2) differ. Table 8 defines the concentration of analytes in the PQLCRI (LL1) analyzed at laboratory target analyte list reporting limits.

11.12. Prior to calibration and between each sample/standard the system is rinsed with the calibration blank solution. The minimum rinse time between analytical samples is 60 seconds unless following the protocol outlined in Section 10.5 it can be demonstrated that a shorter rinse time may be used. Triton-X is added to the rinse solution to facilitate the rinse process.

11.13. To facilitate the early identification of QC failures and samples requiring rerun it is strongly recommended that sample data be reviewed periodically throughout the run.

11.14. To facilitate the data review and reporting processes it is strongly recommended that all necessary dilutions be performed before closing out the instrument run.

11.15. For unattended overnight auto-runs it is strongly recommended that the frequency of ICSA/ICSAB analysis be increased to every 4 hours when they are required by client specific QC requirements.

11.16. Internal standards are added to all of the QC and samples analyzed. The concentration of analytes in the internal standard is defined in Table 11.

11.16.1. Typically used internal standards are: yttrium or scandium. Indium may be used as an alternative. (Note: Any element can be used that is not typically found in environmental samples at a high rate of occurrence.)

11.16.2. The internal standard (IS) must be added to every sample and standard at the same concentration. The internal standard is added to each analytical sample

automatically through use of a third pump channel and mixing coil.

11.16.3. The concentration of the internal standard should be sufficiently high to obtain good precision in the measurement of the IS analyte used for data correction and to minimize the possibility of correction errors if the IS analyte is naturally present in the sample.

11.16.4. The internal standard raw intensity counts must be printed on the raw data.

11.16.5. The analyst must monitor the response of the internal standard throughout the sample analysis run. This information is used to detect potential problems and identify possible background contributions from the sample (i.e., natural occurrence of IS analyte).

11.16.5.1. If the internal standard counts fall within ± 20% of the counts observed in the ICB then the data is acceptable.

11.16.5.2. If the internal standard counts in the field samples are more than ± 20% higher than the expected level, the field samples must then be diluted and reanalyzed, the IS concentrations must be raised, or a different internal standard must be used.

11.17. Full method required QC must be available for each wavelength used in determining reported analyte results.

11.18. Guidelines are provided in Appendix 1 for minimizing contamination of samples and standards, in Appendix 2 for preventive maintenance, and in Table 1 for troubleshooting.

11.19. All measurements must fall within the defined linear range where spectral interference correction factors are valid. Dilute and reanalyze all samples for required analytes that exceed 90% of the linear range or use an alternate wavelength for which QC data are established. If an interelement correction exists for an analyte which exceeds the linear range, the IEC may be inaccurately applied. Therefore, even if an over range analyte may not be required to be reported for a sample, if that analyte is a possible interferent for any requested analyte in that sample, the sample must be diluted, and affected analytes reported from the dilution. Acid strength must be maintained in the dilution of samples.

11.20. For TCLP samples, full four-point MSA will be required if all of the following conditions are met:

11.20.1. Recovery of the analyte in the matrix spike is not at least 50%,

11.20.2. The concentration of the analyte does not exceed the regulatory level, and,

11.20.3. The concentration of the analyte is within 20% of the regulatory level.

11.20.4. The reporting and regulatory limits for TCLP analyses as well as matrix spike levels are detailed in Table 13.

11.20.5. Appendix 1 provides guidance on performing MSA analyses.

11.21. Documentation and Record Management

The following documentation comprises a complete ICP raw data package:

- Raw data (direct instrument printout).
- Relevant sample preparation bench sheets.
- Run log printout from IDB software.
- Documentation of standard Ids.
- Data review checklist and Nonconformance documentation (if applicable).

12. CALCULATIONS/DATA REDUCTION

12.1. ICV percent recoveries are calculated according to the equation:

$$\%R = 100 \times \left(\frac{\text{Found(ICV)}}{\text{True(ICV)}} \right)$$

12.2. CCV percent recoveries are calculated according to the equation:

$$\%R = 100 \times \left(\frac{\text{Found(CCV)}}{\text{True(CCV)}} \right)$$

12.3. Matrix Spike Recoveries are calculated according to the following equation:

$$\%R = 100 \times \left(\frac{SSR - SR}{SA} \right)$$

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

12.4. The relative percent difference (RPD) of matrix spike/matrix spike duplicates are calculated according to the following equations:

$$RPD = 100 \left[\frac{|MSD - MS|}{\left(\frac{MSD + MS}{2} \right)} \right]$$

Where:

MS = determined spiked sample concentration
MSD = determined matrix spike duplicate concentration

12.5. The final concentration for a digested aqueous sample is calculated as follows:

$$mg / L = \frac{C \times V1 \times D}{V2}$$

Where:

C = Concentration (mg/L) from instrument readout
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

12.6. The final concentration determined in digested solid samples when reported on a dry weight basis is calculated as follows:

$$\text{mg / Kg, dry weight} = \frac{\text{C} \times \text{V} \times \text{D}}{\text{W} \times \text{S}}$$

Where:

C = Concentration (mg/L) from instrument readout
D = Instrument dilution factor
V = Final volume in liters after sample preparation
W = Weight in Kg of wet sample digested
S = Percent solids/100

Note: A Percent Solids determination must be performed on a separate aliquot when dry weight concentrations are to be reported. If the results are to be reported on wet weight basis the "S" factor should be omitted from the above equation.

12.7. The LCS percent recovery is calculated according to the following equation:

$$\%R = 100 \times \left(\frac{Found(LCS)}{True(LCS)} \right)$$

12.8. The dilution test percent difference for each component is calculated as follows:

$$\%\ \text{Difference} = \frac{|I - S|}{I} \times 100$$

Where:

I = Sample result (Instrument reading)
S =Dilution test result (Instrument reading × 5)

12.9. Appropriate factors must be applied to sample values if dilutions are performed.

12.10. Sample results should be reported in accordance with this laboratory's significant figure policy (WS-PQA-004).

13. METHOD PERFORMANCE

Prior to analysis of any analyte using Method 6010B, the following requirements must be met:

13.1. Prior to use, the following data must be generated and kept on file for any newly installed instrument: Analytical dynamic range (Section 10.4) determination and verification of interelement correction/spectral interference correction (Section 10.3), and method and instrument detection limits (discussed below).

13.2. Instrument Detection Limit (IDL) – The IDL for each analyte must be determined for each analyte wavelength used on each instrument. The IDL must be determined annually. If the instrument is adjusted in any way that may affect the IDL, the IDL for that instrument must be re-determined.

13.2.1. IDLs shall be determined by multiplying by three the average of the standard deviations obtained on three non-consecutive days from the analysis of a blank solution with seven consecutive measurements per day.

13.2.2. Each measurement must be performed as though it were a separate analytical sample.

13.2.3. Each measurement must be followed by a rinse and/or any other procedure normally performed between the analyses of separate samples.

13.2.4. The IDL measurement must consist of the same number of replicates used for analytical samples with the average result used for reporting.

13.3. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.4. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.4.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.4.2. Calculate the average recovery and standard deviation of the recovery for each

analyte of interest. Compare these to the laboratory generated QC Limits.

13.4.3. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.5. Training Qualification:

The group/team leader or the supervisor has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Acid waste consisting of unused sample, analyzed sample solution and rinse solution. This is collected in four-gallon plastic carboys. When full or after no more than one year, the waste is dumped into an acid waste drum in the H-3 closet. When full to no less than one inch and no more than four inches of the top, or after no more than 75 days, the drum will be transferred to the waste collection area for disposal.

15.2. Miscellaneous disposable glassware, plastic vials with snap top caps, autosampler tubes and similar solid waste. Dump the solid waste into a yellow contaminated lab trash bucket. When the bucket is full, tie the plastic bag liner shut and put the lab trash into the applicable steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, Revision 2, December 1996, Method 6010B.

16.2. Department of Defense Quality Systems Manual for Environmental Laboratories (QSM), Version 3, January 2006.

16.3. 40 CFR Part 136, Appendix B, 7-5-95, Determination of Method Detection Limits.

16.4. WS-IP-0008: Matrix Matching

16.5. WS-PQA-003: Laboratory Wide Quality Control Program

16.6. WS-QA-0006: MDLs and IDLs

17. METHOD MODIFICATIONS

17.1. Modifications/interpretations from Method 6010B.

17.1.1. This laboratory uses mixed calibration standard solutions purchased from approved vendors instead of using individual mixes prepared in house as noted in the methods.

17.1.2. Methods 6010B states that if the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution should fall within a specific concentration range around the calibration blank. In determining IECs, because of lack of definition clarification for "concentration range around the calibration blank," this laboratory has adopted the procedure in EPA CLP ILMO4.0.

17.1.3. Section 8.5 of Method 6010B recommends that whenever a new or unusual matrix is encountered, a series of tests be performed prior to reporting concentration data for that analyte. The dilution test helps determine if a chemical or physical interference exists. Because this laboratory receives no prior information from clients regarding when to expect a new or unusual matrix, the laboratory may select to perform a dilution test on one sample in each analytical batch. According to the method, the post digestion spike (PDS) determines any potential matrix interferences. At this facility, matrix interference is determined by evaluating data for the LCS and MS/MSD. The laboratory requires documented, clear guidance when a new or unusual matrix will be received for a project and a request to perform the dilution test or PDS on a client-identified sample.

17.1.4. IDL's are analyzed annually, or when there is a change to the instrument, instead of quarterly.

17.2. Modifications from Method 6010B

17.2.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method

blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

17.2.2. Method 6010B states that the results of the calibration blank are to agree within 3X the IDL. If not, repeat the analysis two or more times and average the results. If the average is not within three standard deviation of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples. The intent of this requirement is to ensure that the calibration is not drifting at the low end. This laboratory has adopted an absolute control limit of ± RL from zero for calibration blank criteria.

18. ATTACHMENTS

18.1. Appendix 1 – Method of Standard Addition (MSA) Guidance

18.2. Appendix 2 – Contamination Control Guidelines

18.3. Appendix 3 – Preventative Maintenance

18.4. Appendix 4 – Hydrofluoric and Safety Guidelines

18.5. Table 1 – Troubleshooting Guide

18.6. Table 2 –6010B Target Analyte Lists

18.7. Table 3 – Calibration Standard 1 Concentrations: Final Volume = 1000 mL

18.8. Table 4 – Calibration Standard 2 Concentrations: Final Volume = 250 mL

18.9. Table 5 – Calibration Standard 3 Concentrations: Final Volume = 250 mL

18.10. Table 6 – Calibration Standard 4 Concentrations: Final Volume = 250 mL

18.11. Table 7 – ICV4 Concentrations: Final Volume = 500 mL

18.12. Table 8 – ICV2A Concentrations: Final Volume = 500 mL

18.13. Table 9 – PQL CRI Intermediate Standard Concentrations: Final Volume = 100 mL

18.14. Table 10A – ICSA Standard Concentrations: Final Volume = 500 mL

18.15. Table 10B – ICSAB Standard Concentrations: Final Volume = 500 mL

18.16. Table 11 – Internal Standard Concentrations: Final Volume = 500 mL

18.17. Table 12 – Linear Range Standard (QSM Analyses Only): Final Volume = 100 mL

18.18. Table 13 – TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

18.19. Table 14 – Cross Reference of Terms Used in Method 6010B and by the West Sacramento Laboratory

19. REVISION HISTORY

19.1. WS-MT-0003, Revision 5.3, Effective 11/18/2011

19.1.1. Deleted references to Method(s) 200.7 and 6010C.

19.1.2. Updated instrument parameters from PE Optima to Thermo 6500 Duo.

19.1.3. Editorial revisions.

19.2. WS-MT-003, Revision 5.2, Effective 10/22/2010

19.2.1. Modified PQLCRI to be synonymous with LL1.

19.2.2. Modified QAM PQL to be synonymous with LL2.

19.2.3. Modified Section 11.3 window for neublizer argon gas flow from 0.56 L/min to 0.56 ± 0.03 L/min.

19.2.4. Updated Table(s) 2, 4, 5, 6, 7, 8, 9, 11, and 12.

19.3. WS-MT-0003, Revision 5.1, Effective 9/04/2009

19.3.1. Added Section 1.7, “When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.”

19.3.2. Inserted Section 10.1, “For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 “Calibration Curves (General)”.”

19.4. WS-MT-0003, Revision 5, Effective 12/1/2008

19.4.1. Added references to AFCEE 4.0 where applicable.

19.4.2. Reformatted sections to conform to TestAmerica guidelines.

19.4.3. Added method 6010C criteria, including the PQLCRI standard (LL1) at beginning and end of the sequence, and the ± 30% criteria.

19.4.4. Clarified sections 9.11.2.4 and 11.20 to state that interfering elements above the linear range, even when not requested, warrant dilution of samples.

19.4.5. Updated Table 2 to add QSM limits.

19.4.6. Updated Table 9 to include PQL standards.

19.4.7. Editorial changes.

19.5. WS-MT-0003, Revision 4, Effective 1/10/2007

19.5.1. Updated to TestAmerica format. Content was not changed.

19.6. SAC-MT-0003, Revision 4, Effective 1/10/2007

19.7. SAC-MT-0003, Revision 3.2, Effective 1/19/2006

19.7.1. Clarified method requirements for control limits.

19.8. SAC-MT-0003, Revision 3.1, Effective 12/14/2005

19.8.1. Clarified method requirements in Sections 9 and 11.

19.9. SAC-MT-0003, Revision 3, Effective 8/31/2004

19.10. SAC-MT-0003, Revision 2, Effective 1/03/2003

19.11. SAC-MT-0003, Revision 1, Effective 10/03/2000

19.11.1. Updated to STL format.

19.12. CORP-MT-0001, Revision 3, Effective 7/20/1999

19.13. CORP-MT-0001SAC, Revision 2.1, Effective 9/25/1998

19.14. CORP-MT-0001, Revision 2, Effective 12/15/1997

19.15. CORP-MT-0001SAC, Revision 1.1, Effective 8/29/1996

19.16. CORP-MT-0001, Revision 1, Effective 7/21/1995

19.17. CORP-MT-0001, Revision 0, Effective 2/08/1995

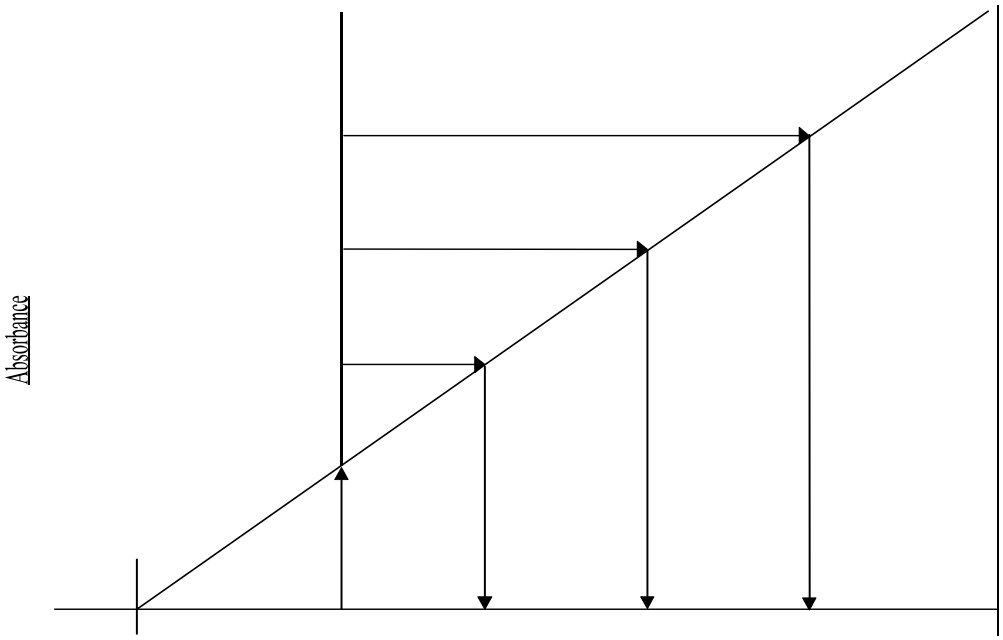
19.17.1. Quanterra format.

19.18. LM-CAL-2089, Revision N/A, Effective 11/16/1987

19.18.1. Enseco format.

Appendix 1 – MSA GUIDANCE (Method of Standard Addition)

Four equal volume aliquots of sample are measured and known amounts of standards are added to three aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked standard should be the same.



In order to determine the concentration of analyte in the sample, the analytical value of each solution is determined and a plot or linear regression performed. On the vertical axis the analytical value is plotted versus the concentrations of the standards on the horizontal axis. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the point of interception of the horizontal axis is the concentration of the unknown.

For the method of standard additions to be correctly applied, the following limitations must be taken into consideration:

- The plot of the sample and standards must be linear over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.
- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

Appendix 2 – Contamination Control Guidelines

Procedures strongly recommended to prevent contamination:

- Clean all work areas used to prepare standards and spikes before and after each use.
- Wash all glassware with detergent and tap water and rinse with 1:1 nitric acid followed by deionized water.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Do not use powdered gloves of any variety, or latex gloves (powdered or powder-free) in the metals laboratory. Both latex and glove powder contain silica, zinc and other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.
- Check glassware for cracks and etches before each use and discard if found. Etched glassware can cause cross contamination of any metallic analytes.
- Cover autosampler trays to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.
- Check laboratory HVAC systems are working properly

Helpful hints in the identification of the source of contaminants:

- Yellow pipette tips and volumetric caps can sometimes contain cadmium.
- Some sample tubes have been found to contain lead and other analytes.
- The markings on glass beakers have been found to contain lead. If acid baths are in use for glassware cleaning, they should be periodically checked for contaminants since contaminant concentrations will increase over time.
- New glassware especially beakers can be a source of silica and boron.
- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- Latex gloves can contain over 500 ppb of zinc.

Appendix 3 – Preventative Maintenance

A maintenance log is used to record when maintenance is performed on instruments. When an instrument problem occurs indicate the date, time and instrument number, then identify the problem and corrective action in the maintenance log. Document when the instrument has returned to control.

The following procedures are required to ensure that that the instrument is fully operational.

Preventive Maintenance Schedule	
Daily	
Check peristaltic pump tubing, sample capillary tubing, tubing joints, and autosampler sipper probe.	Check air, argon, and nitrogen gas pressure
Check rinse solution and fill if needed	Check waste container and empty if needed
Perform data backup from instrument PC	Check back pressure and droplet size to verify nebulizer is not clogged.
Clean plasma injector and torch to remove accumulated deposits	Check / Clean axial and radial purge windows
Check exhaust vent	Monitor manganese intensities during torch alignment
As Needed	
Replace peristaltic pump tubing, sample capillary tubing, tubing joints and autosampler sipper probe.	Replace axial and radial purge windows
Monthly	
Clean exterior of instrument and chiller Clean air filters on instrument and chiller unit to remove dust	Check coolant level in chiller
Biannually	
	Check / Clean coolant filter

Appendix 4 – Hydrofluoric and Safety Guidelines

Washington Occupational Health Associates

1120 19th Street, N. W.
Suite 410
Washington, D.C. 20036
Phone 202-436-6698
or 800-777-WOHA
Fax. 202-223-6525

To: Don Dihel, Corporate Director EH&S, QES
From: Samuel J. Scott, M.D., M.P.H.
Date: June 21, 1999
Re: Safety Measures with use of Hydrofluoric acid

In response to your request for recommendations of safety/emergency supplies and equipment for use in the event of exposure to hydrofluoric acid, we have compiled the following list:

Supplies and Equipment

1. Shower
2. Eye irrigation station
3. Calcium gluconate gel 2.5%
4. Epsom salts
5. Milk of Magnesia
6. Calcium gluconate tablets
7. Oxygen tank, tubing and oxygen mask capable of delivery of 100% oxygen
8. **Special First Aid Kit** containing injectable calcium gluconate solution. This kit should be carried with the employee to the hospital emergency room. It is quite possible the emergency room will not have the necessary supplies necessary to deal with this type of chemical exposure.

First Aid Measures

Skin Contact:

1. Flush area copiously with water for at least 15 minutes.
2. Remove contaminated clothing immediately.
3. After washing exposed skin, use gloves to rub a generous amount of calcium gluconate gel 2.5% into burn area.

4. For areas too large to apply the gel, use an Epsom salts solution in a concentration of ½ to 1 cup of Epsom salts in one quart of iced water. Immerse the limb into a bucket of solution or soak the solution into gauze and apply to the wound. This dressing should be replaced or re-soaked every two minutes.
5. If area affected is greater than 2 inches by 2 inches, give 6 tablets of calcium gluconate orally.
6. If area affected is greater than 4 inches by 4 inches, assume significant inhalation injury and treat accordingly.
7. Except for small burns, refer to the emergency room and continue applying calcium gluconate gel or Epsom salt soaks en route.

Caution: Hydrofluoric acid causes delayed burns over several hours so the immediate care is essential to prevent further harm.

Inhalation:

1. Administer oxygen 100%.
2. Resuscitate as necessary.
3. Transport to the nearest emergency room.

Eye Contact:

1. Immediately flush the eyes at the irrigation station.
2. Get medical assistance immediately.

Ingestion:

1. Do NOT induce vomiting.
2. Have the victim drink two large glasses of water or milk.
3. Give two ounces of milk of magnesia.
4. Give six tablets of calcium gluconate.

I hope this provides the information you requested. Should you have further questions or require additional information, please do not hesitate to contact one of the physicians at WOHA.

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TABLE 1: Troubleshooting Guide

Problem	Possible Cause/ Solution
High Blanks	Increase rinse time Clean or replace tip Clean or replace torch Clean or replace sample tubing Clean or replace nebulizer Check spray chamber is draining Lower Torch
Instrument Drift	Check chiller (not cooling properly) Replace torch, spray chamber (cracked) Clean or replace nebulizer (blockage) Check room temperature (changing) Replace pump tubing Room humidity too high Clean torch tip (salt buildup) Check for argon leaks
Erratic Readings, Flickering Torch or High RSD	Check for argon or air leaks Check nebulizer settings Check pump tubing (clogged, worn) Check spray chamber drainage Increase uptake time or flush time (too short) Check peristaltic pump tension adjustment Clean nebulizer, torch or spray chamber Increase sample volume introduced Check that autosampler tubes are full Sample or dilution of sample not mixed Check integration time (too short) Check torch alignment Check sample matrix
Low Sensitivity	Plasma conditions changed Clean nebulizer, torch or spray chamber Check argon and nitrogen gas Replace tubing (clogged, leaks, worn) Check torch alignment Clean, Replace purge windows Clean, Replace optics

TABLE 2: Method 6010B Target Analyte List

ELEMENT	Symbol	Standard Reporting Limit (ug/L) Water	Standard Reporting Limit (mg/kg) Soil	QSM Reporting Limit (ug/L) Water	QSM Reporting Limit (mg/kg) Soil
Aluminum	Al	200	20	200	21
Antimony	Sb	20	2.0	15	1.5
Arsenic	As	20	2.0	21	2.1
Barium	Ba	5.0	1.0	21	2.0
Beryllium	Be	2.0	0.2	3.0	0.3
Boron	B	100	10	200	20
Cadmium	Cd	2.0	0.2	3.0	0.3
Calcium	Ca	500	50	500	100
Chromium	Cr	8.0	0.5	12	1.2
Cobalt	Co	5.0	0.5	6.0	0.6
Copper	Cu	10	1.5	20	2.5
Iron	Fe	100	10	100	10
Lead	Pb	5.0	1.0	10	2.0
Lithium	Li	20	1.0	—	—
Magnesium	Mg	500	50	500	50
Manganese	Mn	5.0	0.5	12	—
Molybdenum	Mo	20	2.0	30	3.0
Nickel	Ni	5.0	1.0	10	1.0
Phosphorus	P	500	50	500	50
Potassium	K	1000	100	1000	100
Selenium	Se	20	20	25	2.0
Silicon	Si	500	**	—	—
Silver	Ag	5.0	0.5	5.0	0.5
Sodium	Na	1000	100	1000	500
Strontium	Sr	50	5.0	—	—
Sulfur	S	500	50	—	—
Thallium	Tl	20	2.0	15	2.0
Tin	Sn	20	10	—	—
Titanium	Ti	10	1.5	10	3.0
Vanadium	V	5.0	0.5	20	3.0
Zinc	Zn	10	2.0	20	3.0
Zirconium	Zr	20	2.0		

TABLE 3: Calibration Standard 1 Concentrations: Final Volume = 1000 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spike Volume (mL)	Final Concentration (mg/L)
Aluminum (1)	QCAL-1A	10000	5.0	50
Aluminum (2)	QCAL-1A	10000	5.0	50
Antimony	Single source	1000	1.0	1.0
Arsenic	QCAL-5	1000	1.0	1.0
Barium	QCAL-6D	1000	5.0	5.0
Beryllium	QCAL-6D	200	5.0	1.0
Boron	QCAL-6C	1000	2.0	2.0
Cadmium	QCAL-5	1000	1.0	1.0
Calcium	QCAL-2A	10000	5.0	50
Chromium	QCAL-6D	1000	5.0	5.0
Cobalt	QCAL-6D	1000	5.0	5.0
Copper	QCAL-6D	1000	5.0	5.0
Iron (1)	QCAL-1A	10000	5.0	50
Iron (2)	QCAL-1A	10000	5.0	50
Lead	QCAL-5	1000	1.0	1.0
Lithium	QCAL-7B	1000	5.0	5.0
Magnesium	QCAL-2A	10000	5.0	50
Manganese	QCAL-6D	1000	5.0	5.0
Molybdenum	QCAL-6C	1000	2.0	2.0
Nickel	QCAL-6D	1000	5.0	5.0
Phosphorus	QCAL-7B	1000	5.0	5.0
Potassium	See Calibration Std 3			
Selenium	QCAL-5	1000	1.0	1.0
Silicon	See Calibration Std 3			
Silver	Single Source	1000	1.0	1.0
Sodium (1)	QCAL-3A	10000	5.0	50
Sodium (2)	QCAL-3A	10000	5.0	50
Strontium	QCAL-7B	1000	5.0	5.0
Sulfur (1)	See Calibration Std 3			
Sulfur (2)	See Calibration Std 3			
Thallium	QCAL-5	1000	1.0	1.0
Tin	QCAL-7A	1000	5.0	5.0
Titanium	QCAL-6C	1000	2.0	2.0
Vanadium	QCAL-6D	1000	5.0	5.0
Zinc	QCAL-6D	1000	5.0	5.0

TABLE 4: Calibration Standard 2 Concentrations: Final Volume = 500 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spiking Volume (mL)	Final Concentration (mg/L)
Aluminum (2)	QCAL-1A	10000	12.5	250
Calcium	QCAL-2A	10000	12.5	250
Iron (2)	QCAL-1A	10000	12.5	250
Magnesium	QCAL-2A	10000	12.5	250
Phosphorous	Single Source	10000	2.5	50
Sodium (1)	QCAL-3A	10000	12.5	250
Sodium (2)	QCAL-3A	10000	12.5	250

TABLE 5: Calibration Standard 3 Concentrations: Final Volume = 500 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spiking Volume (mL)	Final Concentration (mg/L)
Potassium	Single Source	1000	2.5	5.0
Silicon	QCAL-7A	1000	2.5	5.0
Sulfur (1)	QCAL-7A	1000	2.5	5.0
Sulfur (2)	QCAL-7A	1000	2.5	5.0
Antimony	Single Source	1000	0.5	1.0

TABLE 6: Calibration Standard 4 Concentrations: Final Volume = 250 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spiking Volume (mL)	Final Concentration (mg/L)
Potassium	Single Source	10000	5.0	100
Sulfur (1)	QCAL-7A	10000	5.0	100
Sulfur (2)	QCAL-7A	10000	5.0	100
Phosphorous	Single Source	10000	5.0	100

TABLE 7: ICV4 Concentrations: Final Volume = 500 mL
ICV4 is made from Spex XCAL-56-500
Spiking volume = 5.0 mL

Element	Stock Std Concentration (mg/L)	Final Concentration (mg/L)
Aluminum (1)	100	10
Aluminum (2)	100	10
Antimony	2.5	0.25
Arsenic	2.5	0.25
Barium	10	1.0
Beryllium	2.5	0.25
Boron	5.0	0.5
Cadmium	2.5	0.25
Calcium	100	10
Chromium	10	1.0
Cobalt	10	1.0
Copper	10	1.0
Iron (1)	100	10
Iron (2)	100	10
Lead	2.5	0.25
Lithium	10	5.0
Magnesium	100	10
Manganese	10	1.0
Molybdenum	5.0	0.5
Nickel	10	1.0
Phosphorus	10	1.0
Potassium	100	10
Selenium	2.5	0.25
Silicon	10	1.0
Silver	2.5	0.25
Sodium (1)	100	10
Sodium (2)	100	10
Strontium	10	1.0
Sulfur (1)	See ICV2A	
Sulfur (2)	See ICV2A	
Thallium	2.5	0.25
Tin	10	1.0
Titanium	5.0	0.5
Vanadium	10	1.0
Zinc	10	1.0

TABLE 8: ICV2A Concentrations: Final Volume = 500 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spiking Volume (mL)	Final Concentration (mg/L)
Phosphorous	Single Source	1000	1.0	2.0
Sulfur	Single Source	1000	1.0	2.0
Silicon	Single Source	1000	0.5	1.0
Antimony	Single Source	1000	0.125	0.25

TABLE 9: LL1 Intermediate Standard Concentrations: Final Volume = 100 mL
Intermediate standard made from 1000 mg/L single element sources.
The final LL1 concentration is a 100X dilution of the intermediate standard.

Element	Stock Standard Spike Level (mL)	Intermediate Concentration (mg/L)	Final PQLCRI Concentration (mg/L) = LL1	QSM PQL Intermediate Concentration (mg/L) = LL2	Final QSM PQL Concentration (mg/L) = LL2
Aluminum	1.0	20	0.2	20	0.2
Antimony	0.05	2.0	0.02	3.0	0.03
Arsenic	0.1	2.0	0.02	4.0	0.04
Barium	0.05	0.5	0.005	2.0	0.02
Beryllium	0.02	0.2	0.002	0.3	0.003
Boron	0.5	10	0.1	20	0.2
Cadmium	0.02	0.2	0.002	0.3	0.003
Calcium	1.0	50	0.5	50	0.5
Chromium	0.05	0.5	0.005	1.0	0.01
Cobalt	0.05	0.5	0.005	1.0	0.01
Copper	0.05	1.0	0.01	1.5	0.015
Iron	0.25	210	0.1	10	0.1
Lead	0.03	0.5	0.005	1.0	0.01
Lithium	0.1	1.0	0.01	2.0	0.02
Magnesium	1.0	50	0.5	50	0.5
Manganese	0.05	0.5	0.005	1.0	0.01
Molybdenum	0.1	2.0	0.02	2.0	0.02
Nickel	0.05	0.5	0.005	1.0	00.
Phosphorus	1.0	50	0.5	50	0.5
Potassium	2.5	100	1.0	100	1.0
Selenium	0.05	2.0	0.02	4.0	0.04
Silicon	0.5	50	0.5	50	0.5
Silver	0.05	0.5	0.005	0.5	0.005
Sodium	2.5	100	1.0	50	0.5
Strontium	0.25	5.0	0.05	5.0	0.05
Sulfur	0.5	50	0.5	50	0.5
Thallium	0.1	2.0	0.02	3.0	0.03
Tin	0.2	2.0	0.02	2.0	0.02
Titanium	0.05	1.0	0.01	1.0	0.01
Vanadium	0.05	0.5	0.005	2.0	0.02
Zinc	0.05	1.0	0.01	2.0	0.02

TABLE 10A: ICSA Standard Concentrations: Final Volume = 500 mL
ICSA is made from IV CLPP-ICS-A
Spiking volume = 50

Element	Stock Standard Concentration (mg/L)	Final ICSA Concentration (mg/L)
Aluminum	**5000**	**500**
Calcium	**5000**	**500**
Iron	**2000**	**200**
Magnesium	**5000**	**500**

TABLE 10B: ICSAB Standard Concentrations: Final Volume = 500 mL
ICSAB is made from IV CLPP-ICS-B4 + ICSA
Spiking volume = 5.0 mL

Element	Stock Std Concentration (mg/L)	Final Concentration (mg/L)
Antimony	**60**	**0.6**
Arsenic	**10**	**0.1**
Barium	**50**	**0.5**
Beryllium	**50**	**0.5**
Cadmium	**100**	**1.0**
Chromium	**50**	**0.5**
Cobalt	**50**	**0.5**
Copper	**50**	**0.5**
Lead	**5.0**	**0.05**
Manganese	**50**	**0.5**
Nickel	**100**	**1.0**
Selenium	**5.0**	**0.05**
Silver	**20**	**0.2**
Thallium	**10**	**0.1**
Vanadium	**50**	**0.5**
Zinc	**100**	**1.0**

TABLE 11: Internal Standard Concentrations: Final Volume = 1 L

Element	Stock Standard Concentration (mg/L)	Spiking Volume (mL)	Final Concentration (mg/L)
Yttrium	**1000**	**6.0**	**6.0**

TABLE 12: Linear Range Standard (QSM analyses only): Final Volume = 100 mL

Element	Stock Standard ID	Stock Std Concentration (mg/L)	Spike Volume (mL)	Final Concentration (mg/L)
Antimony	**Single source**	**1000**	**0.5**	**1.0**
Arsenic	**QCAL-5**	**1000**	**0.5**	**5.0**
Barium	**QCAL-6D**	**1000**	**0.5**	**10.0**
Beryllium	**QCAL-6D**	**200**	**0.5**	**2.0**
Boron	**QCAL-6C**	**1000**	**0.5**	**5.0**
Cadmium	**QCAL-5**	**1000**	**0.5**	**5.0**
Chromium	**QCAL-6D**	**1000**	**0.5**	**10.0**
Cobalt	**QCAL-6D**	**1000**	**0.5**	**10.0**
Copper	**QCAL-6D**	**1000**	**0.5**	**10.0**
Lead	**QCAL-5**	**1000**	**0.5**	**5.0**
Lithium	**QCAL-7B**	**1000**	**0.5**	**5.0**
Manganese	**QCAL-6D**	**1000**	**0.5**	**10.0**
Molybdenum	**QCAL-6C**	**1000**	**0.5**	**5.0**
Nickel	**QCAL-6D**	**1000**	**0.5**	**10.0**
Phosphorus	**QCAL-7B**	**1000**	**0.5**	**5.0**
Potassium	**QCAL-7A**	**10000**	**0.5**	**100**
Selenium	**QCAL-5**	**1000**	**0.5**	**5.0**
Silicon	**QCAL-7A**	**1000**	**0.5**	**5.0**
Silver	**Single Source**	**1000**	**0.1**	**1.0**
Sodium (1)	**QCAL-3A**	**10000**	**0.5**	**100**
Sodium (2)	**QCAL-3A**	**10000**	**0.5**	**100**
Strontium	**QCAL-7B**	**1000**	**0.5**	**5.0**
Sulfur	**QCAL-7A**	**1000**	**0.5**	**5.0**
Thallium	**QCAL-5**	**1000**	**0.5**	**5.0**
Tin	**QCAL-7A**	**1000**	**0.5**	**5.0**
Titanium	**QCAL-6C**	**1000**	**0.5**	**5.0**
Vanadium	**QCAL-6D**	**1000**	**0.5**	**10.0**
Zinc	**QCAL-6D**	**1000**	**0.5**	**10.0**

TABLE 13: TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	Reporting Level (ug/L)	Regulatory Limit (ug/L)	Spike Level (ug/L)
Arsenic	500	5000	10000
Barium	10000	100000	10000
Cadmium	100	1000	250
Chromium	500	5000	1000
Lead	500	5000	2500
Selenium	250	1000	10000
Silver	500	5000	250

TABLE 14: Cross Reference of Terms Used in Methods 6010B and the West Sacramento Laboratory

SW6010B	West Sacramento
Calibration blank	Initial and continuing calibration blanks (ICB/CCB)
Dilution test	Dilution Test
Instrument detection limit (IDL)	Instrument detection limit (IDL)
Continuing calibration verification (CCV)	Continuing calibration verification (CCV)
Internal standard	Internal standard (IS)
NA	NA
NA	Laboratory control sample (LCS)
Matrix spike and matrix spike duplicate (MS/MSD)	Matrix spike and matrix spike duplicate (MS/MSD)
Method blank	Method or Prep blank (MB)
Linear dynamic range (LDR)	Linear dynamic range (LDR)
Method detection limit (MDL)	Method detection limit (MDL)
Check standard or Initial calibration verification (ICV)	Initial calibration verification (ICV)
Interference check solution (ICS)	Interference check solution (ICSA/ICSAB)

Title: Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1 [Method SW846 7470A and MCAWW 245.1]

Approvals (Signature/Date):

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Joe Schairer Health & Safety Manager / Coordinator	6/22/12 Date
Douglas Weir Quality Assurance Manager	06/22/12 Date
Karla Buechler Laboratory Director	6/22/12 Date

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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation and analysis of mercury by Cold Vapor Atomic Absorption Spectroscopy (CVAA) using SW-846 Method 7470A and MCAWW Method 245.1. Method 7470A is applicable to the preparation and analysis of mercury in ground water, wastewater, wastes, wipes, TCLP, SPLP, STLC leachates, and samples from stationary source sampling trains . Method 245.1 is applicable to the determination of mercury in drinking, surface and saline water, domestic and industrial wastes. All matrices require sample preparation prior to analysis. This also applies to digestates prepared by SOPs WS-IP-0007.

1.2. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Samples are digested using a combination of acids and strong oxidizers, converting all forms of mercury to mercuric ions. The samples are treated with hydroxylamine hydrochloride solution to remove excess oxidizing reagents. The digestates are analyzed using Leeman Labs automated mercury analyzers. The mercuric ions are reduced to atomic mercury vapor with the addition of stannous chloride into a gas-liquid separator. The mercury vapor is purged into an absorption cell with nitrogen gas. The relative absorbance of the mercury vapor is detected at a wavelength of 253.7- nm via a lamp/detector system.

2.2. Reporting limit: 0.2 µg/L.

2.3. Calibration Range: 0.2 µg/L to 10 µg/L.

2.4. This analytical method is restricted to use by, or under the supervision of an analyst experience in the operation of cold vapor analysis and the evaluation of the resulting data.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Potassium permanganate, which is used to breakdown organic mercury compounds also eliminates possible interference from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of inorganic mercury from reagent water.

4.2. Copper has been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on the recovery of mercury from spiked samples.

4.3. High levels of free chlorine can cause a positive interference. Seawaters, brines and industrial effluents high in chlorides require additional permanganate (as much as 5.0 mL) since chloride is converted to free chlorine during oxidation. Both inorganic and organic mercury spikes have been quantitatively recovered from seawater using this technique.

Note: Sufficient addition of permanganate is apparent when the purple color persists at least 15 minutes. Some samples may require dilution prior to digestion due to extremely high concentrations of chloride.

4.4. Interference from certain volatile organic materials that absorb at this wavelength may also occur. If suspected, a preliminary run without stannous chloride can determine if this type of interference is present.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. The front half air train samples extracted are in a 2% HF solution. The labels fro all such extracts and digestates should be highlighted in yellow. The use of hydrofluoric acid requires special safety precautions. Consult the facility EH&S staff and the local supplement to the Corporate Safety Manual for guidance. Anyone working with HF must receive special training before starting work. Staff members who work around HF should also receive this training. HF and solutions may not be used for any purposes except as prescribed in this or other West Sacramento SOPs. Processes involving HF acid are classified as high-risk activities. Personnel involved must wear a face shield in addition to safety glasses or goggles.

<u>WARNING</u> The West Sacramento Emergency Response Team must be activated for any suspected exposure to HF liquid or fumes. After local emergency response, the victim will be transported to the UCD Medical Center Emergency Room.

5.1.1.1. 2.5% calcium gluconate gel should be applied copiously and gently massaged into burn sites after rinsing under cold running water for one minute to remove HF acid from the surface of the skin. The person massaging should wear appropriate protective gloves. If the victim is conscious, they should consume small quantities of calcium or magnesium containing liquids, such as milk, Maalox, or Milanta. If the burn site is too large for massage with calcium gluconate gel, cover it with gauze soaked in an Epsom salt solution (1 cup to 1 quart of cold water). Keep the wraps saturated with Epsom salt solution.

5.1.1.2. Some metals react with JHF to produce flammable hydrogen gas.

5.1.1.3. Glass reacts with HF to produce toxic silicon tetrafluoride.

5.1.1.4. HF is classified as a poison, and must be stored in a locked cabinet when not in use.

5.1.1.5. Whenever HF is in use in a laboratory, a decontamination solution will be prepared before starting work. Take a small bucket (2-3 gallons) and fill it about 2/3 – 3/4 full with an Epsom salts solution. (1/2 cup of Epsom salts per quart of water). Before removing gloves or handling anything else that HF on the gloves might be transferred to, carefully dip one hand at a time into the Epsom salts solution for a few seconds. Do not put the hand any deeper than necessary to bring the solution level to within 1-2 inches of the glove cuff. The Epsom salts solution will be prepared each day prior to beginning work with HF, and disposed at the end of the day down the laboratory sink.

5.1.2. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled.

5.1.3. Latex, nitrile, and vinyl gloves provide adequate protection against the chemicals and reagents typically used during this process. However, if any organic solvents are used, or any sample matrix contains organic solvents, only nitrile gloves should be used.

5.1.4. Exposure to chemicals must be maintained **as low as reasonably achievable**; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.5. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.6. Mercury is a highly toxic element that must be handled with care. Mercury vapor is toxic, so all work must be done in a functioning fume hood and vapors must be vented into a hood. If any volume of mercury reagent or liquid mercury is spilled, the Emergency Response Team must be activated, code yellow, for spill clean-up.

5.1.7. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.1.8. Do not look directly into the beam of the mercury lamp. The UV light from the lamp is harmful to the eyes.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Hydroxylamine Sulfate	Corrosive	None	Extremely destructive to tissues of the mucous membranes and upper respiratory tract. Corrosive to the eyes. Irritant and possible sensitizer. May cause burns to the skin.
Mercury (1,000 PPM in Reagent)	Oxidizer Corrosive Poison	0.1 mg/m^3 Ceiling (Mercury Compounds)	Extremely toxic. Causes irritation to the respiratory tract. Causes irritation. Symptoms include redness and pain. May cause burns. May cause sensitization. Can be absorbed through the skin with symptoms to parallel ingestion. May affect the central nervous system. Causes irritation and burns to eyes. Symptoms include redness, pain, and blurred vision; may cause serious and permanent eye damage.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydrator Poison	1 mg/m^3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
			occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Nitric Acid (1)	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid (1)	Corrosive Poison	5 PPM-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Potassium Permanganate	Oxidizer	5 mg/m^3 for Mn Compounds	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Dry crystals and concentrated solutions are caustic causing redness, pain, severe burns, brown stains in the contact area and possible hardening of outer skin layer. Diluted solutions are only mildly irritating to the skin. Eye contact with crystals (dusts) and concentrated solutions causes severe irritation, redness, and blurred vision and can cause severe damage, possibly permanent.
Potassium Persulfate	Oxidizer	None	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Causes irritation to skin and eyes. Symptoms include redness, itching, and pain. May cause dermatitis, burns, and moderate skin necrosis.
Hydrofluoric Acid (1)	Poison Corrosive Dehydrator	3 PPM - TWA	Corrosive to the skin and eyes. Contact causes serious skin burns, which may not be immediately apparent or painful. Symptoms may be delayed 8 hours or longer. Severely corrosive to the respiratory tract. Permanent eye damage may occur. **THE FLUORIDE ION READILY PENETRATES THE SKIN CAUSING DESTRUCTION OF DEEP TISSUE LAYERS AND BONE DAMAGE.**
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

EQUIPMENT

5.3. Preventative and routine maintenance is described in the “Schedule of Routine Maintenance” in the QAM Preventative Maintenance (Section 20.2) and Schedule of Routine Maintenance (Table 20.2).

5.4. An autoclave capable of obtaining conditions of 15 psi at 120°C for 15 minutes. The temperature of the autoclave is verified daily using an "LASCAR" , or equivalent, temperature log device. In order to achieve a minimum 15 minutes at 120°C, the autoclave is set for a run duration of 25 minutes.

5.5. Automated mercury analyzers. Leeman PS20011 and HydraAA (or equivalent) both with autosamplers and WinHg Runner 1.5 software version CT Rev. 0.286 (or equivalent).

5.6. Computer with a printer.

5.7. Top-loading balance capable of accurately weighing 0.01 g.

5.8. 14 mL polystyrene test tubes for the autosampler.

5.9. 50 mL centrifuge tubes.

5.10. Nitrogen gas supply.

5.11. Pump windings – dimensions per instrument manufacturer requirements.

5.12. Bottle-top dispenser: re-pipetters.

5.13. Volumetric adjustable air displacement pipets.

5.14. Class A volumetric flasks.

5.15. pH indicator strips (pH range 0-14).

6. REAGENTS AND STANDARDS

6.1. Reagent water is produced by a Millipore nanopure system. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks. Reagent water is checked on a daily basis as per SOP WS-QA-0014, (Monitoring Reagent Grade Laboratory Water).

6.2. Nitric acid (HNO_3), concentrated, analytical reagent grade.

6.3. Sulfuric acid (H_2SO_4), concentrated, analytical reagent grade.

6.4. Potassium permanganate, 5% solution (w/v): Dissolve 5.0 g of potassium permanganate for each 100 mL of reagent water.

6.5. Potassium persulfate, 5% solution (w/v): Dissolve 5.0 g of potassium persulfate for each 100 mL of reagent water.

6.6. Stannous chloride solution: Add 25 g of stannous chloride and 15 mL concentrated HCl to 250 mL of reagent water. This mixture is a suspension and should appear cloudy. This solution must be made every 12 hours.

6.7. Sodium chloride-hydroxylamine sulfate solution: Add 12.0 g of sodium chloride and 12.0 g of hydroxylamine sulfate for each 100 mL of reagent water.

6.8. All standards must be stored in polyethylene or polypropylene bottles.

6.9. 10 ppm mercury standards: Two separate stock standards purchased from separate manufacturers or different lots from the same manufacturer. One standard is used to make the ICV standard and the other for instrument calibration, CCVs, LCSs, and MS/SDs. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year from opening, and must be replaced sooner if verification from an independent source indicates a problem.

Note: Upon receipt of any stock standard, the "Certificate of Analysis" should be immediately filed in the proper location labeled with the receipt date. The receipt date and date the container is opened must be labeled on the container. Also write the new expiration date on the bottle which is the manufacturer's expiration date or one year after opening the stock standard.

6.10. 0.1 ppm working mercury standards (for each stock): add 0.5 mL of stock 10 ppm source standard and 1 mL HNO_3 to a 50 mL volumetric flask and dilute to volume with reagent water. These standards must be made daily.

7. SAMPLE COLLECTION, PRESERVATION AND STORAGE

7.1. Sample holding time for mercury is 28 days from time of collection to the time of analysis.

7.2. Aqueous samples must be preserved with nitric acid to a pH of <2 at the time of sampling and may be stored in either plastic or glass. Refrigeration is not required. Preservation **must** be verified prior to analysis

8. QUALITY CONTROL

8.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A batch must be analyzed within the same time frame. A method blank (MB), laboratory control sample (LCS) or laboratory control sample duplicate (LCSD) are distilled and analyzed as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/SD), or in some instances a sample/sample duplicate. An analysis batch must include all QC samples, however they do not

contribute to the maximum of 20 samples (see policy WS-PQA-003 (Quality Control Program) for more details).

8.2. One method blank must be processed and reported for every 20 samples. If a method blank exceeds +/- the reporting limit, then the samples must be re-extracted. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo (see policy WS-PQA-003(Quality Control Program) for further details).

8.3. A laboratory control sample (LCS) must be processed and reported for every 20 samples prepared and analyzed. A LCS consists of reagent water spiked with the analyte of interest and processed through all of the steps, and at the same time as the associated samples. If a LCS is outside of percent recovery acceptance criteria, all of the samples associated with that LCS must be re-extracted. One exception is when a LCS exhibits a high recovery, those samples with analyte concentrations less than the reporting limit can be reported. All corrective actions must be documented on a Non-conformance memo (see policy WS-PQA-003 (Quality Control Program) for further details).

8.4. A matrix spike/matrix spike duplicate (MS/MSD or MS/SD) pair must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. MS/MSD pairs are aliquots of a selected field sample spiked with a known concentration of the analyte of interest. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside control limits must be within control limits in the LCS. Re-extraction of the blank, LCS, selected field samples, and/or the MS/MSD may be required after evaluation and review.

Note: For air train samples the MS/MSD is typically performed on one Back Half (HNO_3/H_2O_2) fraction.

8.4.1. Samples identified as field blanks, equipment blanks, or trip blanks should not be used for sample/sample duplicate nor MS/MSD analysis.

8.4.2. A laboratory control sample (LCS or LCS/LCSD) may be substituted when insufficient volume is provided to process a sample/sample duplicate or MS/MSD pair if required by program or client. The LCS and LCSD are evaluated independently for acceptance (see policy QA-003-SAC (Quality Control Program) for further details.

8.5. Initial Calibration Verification (ICV/ICB) – Calibration accuracy is verified by analyzing a second source standard immediately upon completion of instrument calibration. This standard must be at a concentration different from that used to calibrate the instrument and different from the CCV standard. The ICV must fall within +/- 10% of the true value of the standard solution. An ICB prepared the same as

the calibration blank must be analyzed immediately following the ICV to monitor low level accuracy and system cleanliness. The ICB result must fall within +/- the reporting limit from zero. If either the ICV or ICB fail to meet acceptance criteria the analysis must be terminated, the problem corrected, and the instrument re-calibrated.

8.6. Continuing Calibration Verification (CCV/CCB) - Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard after every 10 samples. Ten samples include any analysis that registers with a result, even if not used. The CCV must be a mid-range standard at a concentration other than that of the ICV. The CCV result must fall within 20% of the true value for that solution. A CCB is analyzed immediately following each CCV. The CCB result must fall within +/- RL from zero. Each CCV and CCB analyzed must reflect the conditions of analysis of all associated samples. Sample results may only be reported when bracketed by valid ICV/CCV and ICB/CCB pairs. If a mid-run CCV or CCB fails, the analysis must be terminated, the problem corrected, the instrument re-calibrated, the calibration verified, and the affected samples reanalyzed. If the cause of the CCV or CCB failure was not directly instrument related the corrective action includes re-preparation of the associated samples.

9. CALIBRATION

9.1. All air displacement pipettes must be calibrated over their range of use at least monthly. If the analyst suspects a spiking volume problem, calibration may be required more often. See SOP WS-QA-0004 for pipettor calibration verification procedures.

9.2. All volumetric digestion vessels must be calibrated according to the frequency and procedures outlined in SOP WS-QA-0004. Prior to removing digestion vessels from the vendors box, verify that the box has a “TestAmerica Passed QC” sticker affixed to the outside. If there is not a sticker affixed, contact QA and have the lot checked before use..

9.3. All balances must be calibrated daily before use according to the procedures outlined in SOP WS-QA-0041.

9.4. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 “Calibration Curves (General)”.

9.5. Instrument calibration must be performed daily (once every 24 hours) or each time the instrument is off or non-operational for more than two hours.

9.6. Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (approximately 30 minutes of warm-up is required). Refer to the facility

specific instrument SOP and CVAA instrument manual for detailed setup and operation protocols.

9.7. Calibration standards must be processed through the preparation procedure as described in Section 11.9. Calibration standards must be prepared daily.

9.8. Calibrate the instrument according to instrument manufacturer's instructions, using a minimum of five standards and a calibration blank. One standard must be at the reporting limit. Analyze standards in ascending order beginning with the blank

9.8.1. Calibration standard concentrations and the volume of 0.1 ppm working standard required to make 30 mL of standard:

0.1 ppm Hg Volume (mL)	0.06	0.15	0.3	1.5	3.0
Final Concentration (µg/L)	0.2	0.5	1.0	5.0	10.0

9.8.2. 30 g of 2% HNO_3 is added to each digestion vessel. An adjustable volumetric pipette is used to remove a volume of 2% HNO_3 corresponding to the spiking volume for that standard. The standard is then spiked with the appropriate volume of 0.1 ppm Hg standard.

9.9. The calibration curve must have a correlation coefficient of ≥0.995 or the instrument shall be stopped and re-calibrated prior to running samples. Sample results cannot be reported from a curve with an unacceptable correlation coefficient.

9.10. The concentration of the ICV (section 9.5) is 2.0 ppb made by diluting 0.6 mL of the 0.1 ppm alternate source intermediate to 30 mL total volume with 2% HNO_3. See Section 10.4.2 for the spiking procedure.

9.11. The 5.0 ppb CCV is the same as the calibration standard.

9.12. The autoclave is monitored daily to assure samples are digested for the proper time interval at the appropriate temperature. An "ERTCO" temperature logging device is put in the autoclave and undergoes the same program as the samples. This device can be connected to a computer and a program generates a graph of time vs temperature. These are submitted with the raw data.

10. PROCEDURE

10.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

10.2. All preparation procedures must be carried out in a properly functioning hood.

10.3. All samples are to be checked out and back into sample control with the chain of custody documentation filled out completely. Samples are to be returned to the sample control area once all of the digestions have been initiated.

10.4. Proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be accurate and legible. Always set the samples up on the sample cart in the order with which they are to be dispensed. Double-check the sample bottle IDs, once prior to pouring them into the digestion vessels and again before they are returned to the sample cart.

10.5. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludge and tissues (animal/plant) are usually logged in with solid test codes. When initiating preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous but it appears more like a waste (biphasic, sludge-like, organic liquid, lots of sediment etc.) contact the lab supervisor or project manager for further instructions. In some cases it may be more appropriate to process these samples as solids.

10.6. **Always** read the QAS for every project prior to establishing batch associations. This is meant to assure that all client requirements are satisfied and it also aids in creating more efficient batches. Setting up batches to minimize QC and meet all client requirements is a skill that must be developed by all new personnel with the aid of skilled sample preparation and analytical staff.

10.7. The following procedure must be followed for all aqueous sample preparations:

10.7.1. Use a small aliquot of each sample and measure the pH with pH indicator strips. If the bottles have an “X” on the tops, they have already been tested for other tests and do not require this step.

10.7.1.1. For samples with pH<2 put an “X” on top of the bottle indicating the samples were properly preserved. For these samples, record pH<2 on the preparation log.

10.7.1.2. For samples that test pH>2, notify the project manager immediately so they can contact the client. If the client requests the sample be preserved by the laboratory, add HNO_3 in 1.0 mL aliquots until the sample remains at pH<2 for at least 10 minutes. Let the sample stand for 24 hours and re-test the pH prior to preparation. As long as the

pH<2, the sample can then be digested. A non-conformance memo must be created with an accounting of the anomalous event and the corrective action. A "Sample Preservation Log" must also be completed and filed with the raw data. Record "AF" for "Anomaly Filed" on the digestion log. Put an "X" on top of the bottle indicating the samples were properly preserved.

10.8. Sample Preparation:

10.8.1. All calibration and QC standards must be prepared in the same manner as the samples and be processed through all steps of the preparation procedure.

10.8.2. Transfer 30 mL of **well-mixed sample** to a 50 mL graduated centrifuge tube. The MS/SD sample should be shaken between pouring the separate aliquots.

10.8.2.1. For Air Train samples see SOP WS-IP-0007 for sample preparation procedures. For EPA Method 29, EPA Method 0060, or CARB 436 preparations on Air Trains:

10.8.2.1.1. Transfer 30mL of the $KMnO_4$ filtrate to a 50mL graduated centrifuge tube. (**WARNING:**: Front Half contains hydrofluoric acid.).

10.8.2.1.2. Transfer 30mL of the HCl filtrate into a 50mL graduated centrifuge tube.

10.8.2.1.3. Pipette 3mL of the Back Half Nitric Peroxide filtrate into a 50mL graducated centrifuge tube.

10.8.2.1.4. Pipette 3mL of the condensate into a 50mL graduatted centrifuge tube.

10.8.3. TCLP extracts are diluted 5X and STLC extracts diluted 10X prior to digestion. LCS and MS/SD spiking levels are 1.0 ppb times the dilution factor.

10.8.4. For each method blank and LCS required, weigh out 30 g of water. For the LCS, remove 0.3 mL with an adjustable volumetric pipette. Add 0.3 mL of the 0.1 ppm Hg intermediate used to make the calibration standards. The LCS mercury concentration is 1.0 ppb.

Note: For EPA Method 29, 0060 or CARB 36 samples add 27 mL of deionized nanopure H_2O to the Back Half (HNO_3/H_2O_2) and condensate.

10.8.5. For each MS/SD, spike the samples directly with 0.3 mL of the 0.1 ppm Hg intermediate used to make the calibration standards. The MS/SD mercury concentration is 1.0 ppb.

10.8.5.1. EPA Method 29 and EPA Method 0060: Add 27mL of DI Nanopure water to the Back Half Nitric Peroxide and Condensate.

10.8.6. Add 2.0 mL of concentrated H_2SO_4 and 1.0 mL of concentrated HNO_3, to all samples and standards, mixing after each addition.

10.8.7. Add 5.0 mL of potassium permanganate solution. For samples high in organic materials or chlorides, additional permanganate may be added. Shake and add additional portions of permanganate solution until a purple color persists for at least 15 minutes. If additional Potassium Permanganate needs to be added to one of the samples, it also need to be added to all other samples in the batch and the QC samples (MB, LCS, MS, MSD and the curve). If after the addition of up to 5 mL additional permanganate the color does not persist, sample dilution may be required.

Note: When reporting analyses, the addition of excess reagent must be addressed through mathematical correction of the results to account for the resultant dilution effect.

10.8.8. Add 2.5 mL of potassium persulfate solution.

10.8.9. Autoclave for 25 minutes at 120 °C and 15 lbs (to maintain temperature for 15 minutes).

10.8.9.1. Allow the autoclave to cool to less than 80°C where there is no psi of pressure remaining.

<u>Warning:</u> Caution must be used when opening the door of the autoclave as superheated steam may be present and can cause significant burns.

10.8.10. Allow all of the samples to cool to room temperature. Check that the volume is 30 mL. If volume is <30 mL, add reagent H_2O to bring volume to 30 mL. If volume is >30 mL, record the volume.

10.9. Sample Analysis:

10.9.1. When ready to begin analysis, add 2mL of sodium chloride-hydroxylamine sulfate solution to the samples to reduce the excess permanganate (the permanganate has been reduced when no purple color remains). Mercury analysis is run using a Leeman PS200II or Hydra AA automated mercury analyzer. Results are reported as ug/L Hg.

10.9.1.1. Make certain the lamp is on and the pump windings are working properly. Replace any pump windings that do not exhibit a smooth flow of liquid or look stretched or flattened.

Warning: Do not look directly into the beam of the mercury lamp. The UV light from the lamp is harmful to the eyes.

10.9.1.2. Load the samples into the automated sampler racks according to the sample lists entered into the computer. Do a final check once all samples have been loaded on to the racks to assure proper sequencing.

Note: Samples generated from air trains must be analyzed in duplicate with the average reported sample poured into two tubes for analysis.

10.9.1.3. Stannous chloride is automatically added to the samples by the instrument via the peristaltic pump and mixed with the sample in a liquid-gas separator. This must be freshly prepared every 12 hours.

10.9.2. Dilute and reanalyze all samples that exceed the 10 ppb linear range of the calibration.

10.9.3. If the sample results are negative and the absolute value of the negative result is greater than the reporting limit, the sample must be diluted and reanalyzed.

10.9.4. The samples must be allowed to cool to room temperature prior to analysis or a decrease in the response signal can occur.

10.9.5. Baseline correction is acceptable as long as it is performed after every sample or after the CCV and CCB; resloping is acceptable as long as it is immediately preceded and followed by a compliant CCV and CCB.

10.9.6. For TCLP samples, full four point MSA will be required if all of the following conditions are met:

10.9.6.1. Recovery of the analyte in the matrix spike is less than 50%;

10.9.6.2. The concentration of the analyte does not exceed the regulatory level;

10.9.6.3. The concentration of the analyte is within 20% of the regulatory level.

10.10. To facilitate the early identification of QC failures and samples requiring rerun it is strongly recommended that sample data is reviewed periodically throughout the run.

11. CALCULATIONS/DATA REDUCTION

11.1. ICV/CCV percent recoveries are calculated according to the equation:

$$\%R = 100\left(\frac{Found_{(ICV\,/\,CCV)}}{True_{(ICV\,/\,CCV)}}\right)$$

11.2. Matrix spike recoveries are calculated according to the following equation:

$$\%\ R\ =\ 100\left(\frac{SSR\ -\ SR}{SA}\right)$$

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

11.3. The relative percent difference (RPD) of matrix spike/matrix spike duplicates or sample duplicates are calculated according to the following equations:

$$RPD = 100\left[\frac{|MSD - MS|}{\left(\frac{MSD + MS}{2}\right)}\right]$$

Where:

MS = determined spiked sample concentration
MSD = determined matrix spike duplicate concentration

$$RPD = 100\left[\frac{|DU1 - DU2|}{\left(\frac{DU1 + DU2}{2}\right)}\right]$$

Where:

DU1 = Sample result
DU2 = Sample duplicate result

11.4. The final concentration for an aqueous sample is calculated as follows:

$$\mu g/L = \text{ C x D}$$

Where:

C = Concentration ($\mu g/L$) from instrument readout
D = Instrument dilution factor

11.5. The LCS percent recovery is calculated according to the following equation:

$$\%R = 100\left(\frac{Found_{(LCS)}}{True_{(LCS)}}\right)$$

11.6. Appropriate factors must be applied to sample values if dilutions are performed.

11.7. Sample results should be reported with up to three significant figures in accordance with the TestAmerica West Sacramento significant figure policy (see QA-004-SAC, Rounding and Significant Figures).

12. METHOD PERFORMANCE

12.1. Method Detection Limit

12.2. Each laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in WS-QA-006 and policy S-Q-003.

12.3. Initial Demonstration

Each analyst must make a one time initial demonstration of capability for each individual method. Demonstration of capability for both soils and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

12.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid level calibration standard.

12.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these results with the historical acceptance criteria.

12.3.3. If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.4. Training Qualification

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

13. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must

abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

14. WASTE MANAGEMENT

14.1. The following waste streams are produced when this method is performed.

14.1.1. Unused acidic digestate from the preparation process and remaining in the plastic tubes on the instrument. This acidic liquid is consolidated into a plastic LLE drum. When the drum is full or after no more than 75 days, move this drum to the main waste area for shipment

14.1.2. Aqueous acidic waste from the auto-analyzer. This is collected in a 1-gallon carboy. When the carboy is full, or after no more than one year, consolidate it into a plastic LLE drum for shipment.

14.1.3. Contaminated plastic vials from digestion and analysis. Pour any excess/unused sample from the vial into the aqueous acidic waste drum. Put the plastic vial into the contaminated lab trash. Collect all of the contaminated vials in a plastic bag, and move it to the waste collection area for shipment.

15. REFERENCES/CROSS REFERENCES

15.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update II, Revision I, September 1994, Method 7470A (Mercury).

15.2. "Methods for the Chemical Analysis of Water and Wastes", EPA-600/4-79-020, U.S.EPA, August 1983, Method 245.1.

15.3. WS-PQA-003, Quality Control Program.

15.4. WS-PQA-004, Rounding and Significant Figures.

15.5. WS-QA-006, Method Detection Limits and Instrument Detection Limits.

15.6. WS-QA-023, Nonconformance and Corrective Action System.

15.7. WS-IP-0007, Determination of Metals Emissions From Stationary Sources

16. METHOD MODIFICATIONS

16.1. Modification from Method 7470A and 245.1.

16.1.1. The method has been modified for use with Leeman automated analyzers. The samples are prepared to a total volume of 30 mL versus the 100 mL

volume specified in both methods. The addition of all reagents is modified relative to this decrease in volume. Stannous chloride in HCl is used in place of Stannous sulfate in H_2SO_4 (per instrument instructions). The analytical method is automated, whereas both methods are written for manual CVAA analysis.

16.1.2. STLC leachate analysis has been added to the methods.

16.1.3. The five point curve used by TestAmerica West Sacramento has a 0.2 ppb Hg standard to accommodate analysis of one standard at our 0.2 ppm reporting limit. Both reference methods start with a 0.5 ppb Hg standard and include a 2.0 ppb Hg standard. We do not run the 2.0 ppb Hg standard.

17. ATTACHMENTS

17.1. Appendix A-MSA Guidance

17.2. Appendix B-Contamination Control Guidelines

18. REVISION HISTORY

18.1. WS-MT-0005, Revision 5.4, Effective 06/22/2012.

18.1.1. Updated Section 10.8.7 to address procedure for adding extra Potassium Permanganate to samples.

18.1.2. Editorial changes.

18.2. WS-MT-0005, Revision 5.3, Effective 12/23/2011.

18.2.1. Updated Section 5 to address safety precautions to use with HF acid.

18.2.2. Added Section 6.1 addressing preventative maintenance statement.

18.2.3. Updated Section 6.2 addressing autoclave conditions and monitoring.

18.2.4. Updated Section 6.3 addressing instrumentation and software

18.2.5. Editorial changes.

18.3. WS-MT-0005, Revision 5.2, Effective 02/17/2010

18.3.1. Editorial changes.

18.3.2. Revised note following Section 7.9 to include expiration date on label affixed to standard bottle.

18.3.3. Revised Section 7.1 to read "Reagent water is checked on a daily basis as per SOP WS-QA-0014, (Monitoring Reagent Grade Laboratory Water).

18.3.4. Revised Section 10 to include parameters for calibrating pipettors, balances, and digestion vessels.

18.4. WS-MT-0005, Revision 5.1, Effective 9/04/2009

18.4.1. Added Section 1.5, "When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPP Implementation" must be checked and incorporated."

18.4.2. Inserted Section 10.1, "For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)"."

18.5. WS-MT-0005, Revision 5, Effective 12/03/2008

18.5.1. The SOP format was updated to TestAmerica format and air trains added.

18.5.2. Removed Appendix C, Autoclave Usage Letter, as autoclave use is now published in method 7470.

18.5.3. Corrected reagent name in Sections 5.2, 7.7 and 11.9.1 from "Sodium chloride – hydroxylamine hydrochloride" to "Sodium chloride – hydroxylamine sulfate."

18.6. SAC-MT-0005, Revision 4.1, Effective 12/22/2005

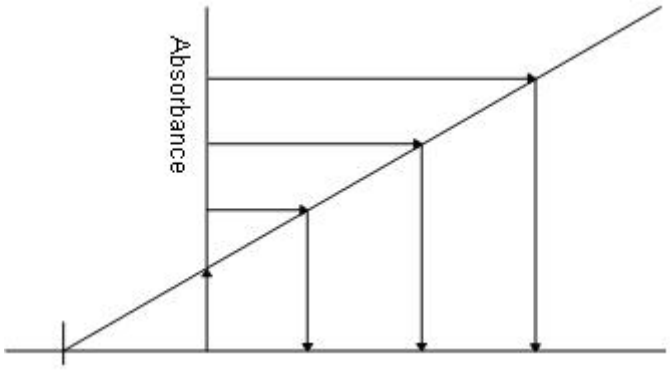
18.6.1. Monitoring of autoclave by use of temperature logging device was added (Section 10.8)

APPENDIX A. MSA GUIDANCE
Method of Standard Addition

Four equal volume aliquots of sample are measured and known amounts of standards are added to three aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked aliquots should be the same (i.e., the volume of the spike added should be negligible in relation to the volume of sample).

To determine the concentration of analyte in the sample, the absorbance (or response) of each solution is determined and a linear regression performed. On the vertical axis the absorbance (or response) is plotted versus the concentrations of the standards on the horizontal axis using 0 as the concentration of the unspiked aliquot. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the point of interception of the horizontal axis is the concentration of the unknown. Calculate the correlation coefficient (r) and the x-intercept (where y=0) of the curve. The concentration in the digestate is equal to the negative x-intercept.

Figure 1



- For the method of standard additions to be correctly applied, the following limitations must be taken into consideration:

- The plot of the sample and standards must be linear over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.

- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

APPENDIX B. CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause-cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

Title: Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption [Method 7471A & 245.5]

Approvals (Signature/Date):

David Allameh — Date 1/16/12 Technical Manager	Joe Schairer — Date 1/16/2012 Health & Safety Manager / Coordinator
Douglas Weir — Date 01/24/12 Quality Assurance Manager	Karla Buechler — Date 1/24/12 Laboratory Director

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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation and analysis of mercury by Cold Vapor Atomic Absorption Spectroscopy (CVAA) using SW-846 Method 7471A and MCAWW Method 245.5. These methods are applicable to the preparation and analysis for total mercury in soils, sediments, bottom deposits, and sludge materials. All matrices require sample preparation prior to analysis. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPP Implementation" must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Samples are digested using a combination of acids and strong oxidizers, converting all forms of mercury to elemental mercury. The samples are treated with hydroxylamine hydrochloride solution to remove excess oxidizing reagents. The digestates are analyzed using an automated mercury analyzer. The mercuric ions are reduced to atomic mercury vapor with the addition of stannous chloride into a gas-liquid separator. The mercury vapor is purged into an absorption cell with nitrogen gas, and the relative intensity detected via a lamp/detector system. The concentration of mercury is calculated using linear regression via a computer and Leeman Labs software.

2.2. Reporting limit: 0.04 mg/Kg

2.3. Calibration Range: 0.017 mg/Kg to 0.83 mg/Kg

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Potassium permanganate, which is used to breakdown organic mercury compounds also eliminates possible interferences from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of inorganic mercury from reagent water.

4.2. Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on the recovery of mercury from spiked samples.

4.3. High levels of chloride can result in a positive interference from the release of free chlorine.

***Note**: Sufficient addition of permanganate is apparent when the purple color persists at least 15 minutes. Some samples may require dilution prior to digestion due to extremely high concentrations of chloride.*

4.4. Interference from certain volatile organic materials that absorb at this wavelength may also occur. If suspected, a preliminary run without stannous chloride can determine if this type of interference is present.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Mercury is a highly toxic element that must be handled with care. Mercury vapor is toxic, so all work must be done in a functioning fume hood and vapors must be vented into a hood. If there any volume of mercury reagent or liquid mercury is spilled, the Emergency Response Team must be activated, code yellow, for spill clean-up.

5.1.2. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.1.3. Do not look directly into the beam of the mercury lamp. The UV light that these lamps generate is harmful to the eyes.

5.1.4. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled.

5.1.5. Latex, nitrile and vinyl gloves provide adequate protection against the chemicals and reagents typically used during this process. However, if any organic solvents are used, or any sample matrix contains organic solvents, only nitrile gloves should be used.

5.1.6. Exposure to chemicals must be maintained **as low as reasonably achievable**; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.7. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydroxylamine Hydrochloride	Corrosive Poison	None	Extremely destructive to tissues of the mucous membranes and upper respiratory tract. Corrosive to the eyes. Irritant and possible sensitizer. May cause burns to the skin.
Mercury (10mg/L in stock standard, 0.1 mg/L in working standard)	Oxidizer Corrosive Poison	0.1 Mg/M3 Ceiling (Mercury Compounds)	Extremely toxic. Causes irritation to the respiratory tract. Causes irritation. Symptoms include redness and pain. May cause burns. May cause sensitization. Can be absorbed through the skin with symptoms to parallel ingestion. May affect the central nervous system. Causes irritation and burns to eyes. Symptoms include redness, pain, and blurred vision; may cause serious and permanent eye damage.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydrator Poison	1 Mg/M3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.

Nitric Acid (1)	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Potassium Permanganate	Oxidizer	5 Mg/M3 for Mn Compounds	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Dry crystals and concentrated solutions are caustic causing redness, pain, severe burns, brown stains in the contact area and possible hardening of outer skin layer. Diluted solutions are only mildly irritating to the skin. Eye contact with crystals (dusts) and concentrated solutions causes severe irritation, redness, and blurred vision and can cause severe damage, possibly permanent.
Potassium Persulfate	Oxidizer	None	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Causes irritation to skin and eyes. Symptoms include redness, itching, and pain. May cause dermatitis, burns, and moderate skin necrosis.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Preventative and routine maintenance is described in the “Schedule of Routine Maintenance” in the QAM Preventative Maintenance (Section 20.2) and Schedule of Routine Maintenance (Table 20.2).

6.2. An autoclave capable of obtaining conditions of 15 psi at 120 °C for 15 minutes. The temperature of the autoclave is verified daily using an “LASCAR” temperature log device. In order to achieve a minimum of 15 minutes at 120 °C, the autoclave is set for a run duration of 25 minutes.

6.3. Automated mercury analyzers: Leeman PS200II and HydraAA (or equivalent) both with autosamplers and WinHg Runner 1.5 software, version CT Rev. 0.286 (or equivalent).

6.4. Computer and printer.

6.5. Top-loading balance capable of weighing 0.01 g

6.6. 40 mL plastic test tubes for the autosampler standards.

6.7. 14 mL test tubes for autosampler sample analysis.

6.8. 100 mL polypropylene containers.

6.9. 50 mL centrifuge tubes.

6.10. Nitrogen gas supply.

6.11. Calibrated (daily) bottle-top dispenser.

6.12. Calibrated adjustable air displacement pipettes.

6.13. Class A volumetric flasks.

6.14. Teflon® boiling chips.

7. REAGENTS AND STANDARDS

7.1. Use reagent grade chemicals in all tests. "Certificates of Analysis" should be supplied with all chemicals purchased. If not supplied, contact the vendor. When received, label the certificate and the reagent container with the receipt date. Scan the "Certificate of Analysis" into the public drive- N:\Certificates of Analysis\Metals\Hg _COA. Reagent containers also need to be labeled with the opened and expiration dates.

7.2. Reagent water is produced by a Millipore Nanopure system. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.3. All standards must be stored in polyethylene or polypropylene bottles.

7.4. 10 mg/L stock mercury calibration solution: Obtained from a commercial vendor. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year from opening, and must be replaced sooner if verification from an independent source indicates a problem.

7.5. 10 mg/L stock alternative source (ICV) mercury solution: Obtained from a different commercial vendor or with a different Lot ID from that of the calibration stock mercury solution. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year from opening, and must be replaced sooner if verification from an independent source indicates a problem.

7.6. 0.1 mg/L intermediate calibration standard: add 0.5 mL of the 10 mg/L stock calibration standard (Section 7.4) and 1 ml of concentrated HNO_3 to a 50 mL volumetric flask and dilute to volume with reagent water. This intermediate mercury standard must be made daily.

7.7. 0.1 mg/L intermediate ICV standard: add 0.5 mL of the 10 mg/L stock ICV standard (7.5) and 1 ml of concentrated HNO_3 to a 50 mL volumetric flask and dilute to volume with reagent water. This intermediate mercury standard must be made daily.

7.8. Nitric acid (HNO_3), concentrated, trace metal grade.

7.9. Sulfuric acid (H_2SO_4), concentrated, trace metal grade.

7.10. Hydrochloric acid (HCl), concentrated, trace metal grade.

7.11. 10% HCl rinse solution: Add 250 mL of concentrated HCl to the rinse bottle and dilute to a final volume of 2.5L with reagent water.

7.12. Stannous chloride solution: Add 50 g of stannous chloride and 30 mL concentrated HCl and dilute to 500 mL with reagent water. This mixture is a suspension and should appear cloudy. This solution must be made daily.

7.13. Sodium chloride-hydroxylamine hydrochloride solution: Dissolve 240 g of sodium chloride and 240 g of hydroxylamine hydrochloride into 2000 mL of reagent water.

7.14. Potassium permanganate, 5% solution (w/v): Dissolve 100 g of potassium permanganate into 2000 mL of reagent water.

7.15. Potassium persulfate, 5% solution (w/v): Dissolve 100 g of potassium persulfate into 2000 mL of reagent water.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding time for mercury is 28 days from time of collection to the time of analysis.

8.2. Solid samples should stored at 4°C ± 2°C until the time of analysis.

9. QUALITY CONTROL

9.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A batch must be prepared within the same time frame. A method blank (MB) and a laboratory control sample (LCS) or duplicate control sample (LCS/LCSD) must be prepared as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/SD), or in some instances a sample/sample duplicate. A 5X Serial Dilution is performed for all DOD programs. An analysis batch must include all QC samples, however they do not contribute to the maximum of 20 samples. See policy WS-PQA-003 of the Quality Control Program for more details.

9.2. One method blank (MB) must be prepared for every 20 samples. A method blank consists of boiling chips processed through all of the steps, and at the same time as the associated samples. If a method blank exceeds ± the reporting limit for a given analyte than the samples associated with that batch must be re-prepared. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo. See policy WS-PQA-003 of the Quality Control Program for further details.

9.2.1. For samples analyzed under DoD QSM, the results of the method blank must be ½ the RL for a given analyte.

9.2.2. For samples analyzed under AFCEE 3.1, the method blank must be ± the RL from zero.

9.3. A laboratory control sample (LCS) must be prepared for every 20 samples. An LCS consists of boiling chips spiked with the analytes of interest and processed through all of the steps, and at the same time as the associated samples. If an LCS is outside of percent recovery acceptance criteria, all of the samples associated with that LCS must be re-prepared except when an LCS exhibits high recovery. For those samples with analyte concentrations less than the reporting limit can be reported. All corrective actions must be documented on a Non-conformance memo. See policy WS-PQA-003 of the Quality Control Program for further details.

9.3.1. For samples analyzed under DoD QSM3, there is no exception for reporting "ND" samples for a high LCS.

9.4. A Matrix Spike/Matrix Spike Duplicate (MS/MSD) pair must be prepared with every process batch of similar matrix, not to exceed twenty (20) samples. MS/MSD pairs are aliquots of a selected field sample spiked with all of the analytes of interest at known concentrations. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside control limits must be within control limits in the LCS. Re-extraction of the blank, LCS, selected field samples, and the MS/MSD may be required after evaluation and review of the MS/MSD results.

Note: Samples identified as field blanks, equipment blanks, or trip blanks should not be used for MS/MSD analysis.

9.5. A duplicate control sample (LCS/LCSD) may be substituted when insufficient volume is provided to process a MS/MSD pair, and batch precision is required by client or program. The LCS and LCSD are evaluated independently for acceptance. See policy WS-PQA-003 of the Quality Control Program for further details.

9.6. Quality Assurance Summaries: Certain clients may require specific project or program QA information that supersedes the SOP requirements. Quality Assurance Summaries

(QAS) should be developed by the PMs to address these requirements. Sample preparation analysts are required to read and print each QAS for every project they prepare. These are transferred to the instrument analysts with the sample digestions.

9.7. Initial Calibration Verification (ICV/ICB) - Calibration accuracy is verified by analyzing a second source standard (ICV). The ICV result must fall within 10% of the true value for that solution. An ICB prepared the same as a method blank is analyzed immediately following the ICV to monitor low level accuracy and system cleanliness. The ICB result must fall within ± the reporting limit (RL) from zero for DoD QSM. If either the ICV or ICB fail to meet criteria, the analysis must be terminated, the problem corrected, and the instrument recalibrated. If the cause of the ICV or ICB failure is not directly instrument related, the corrective action will include repreparation of the associated samples.

9.8. Continuing Calibration Verification (CCV/CCB) - Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard after every 10 samples. Ten samples include any analysis that registers with a result, even if not used. The CCV must be a mid-range standard at a concentration other than that of the ICV. The CCV result must fall within 20% of the true value for that solution. A CCB is analyzed immediately following each CCV. The CCB result must fall within +/- RL from zero. Each CCV and CCB analyzed must reflect the conditions of analysis of all associated samples. Sample results may only be reported when bracketed by valid ICV/CCV and ICB/CCB pairs. If a mid-run CCV or CCB fails, the analysis must be terminated, the problem corrected, the instrument recalibrated, the calibration verified and the affected samples reanalyzed. If the cause of the CCV or CCB failure was not directly instrument related the corrective action will include repreparation of the associated samples.

9.8.1. For DoD QSM, the CCB results for all analytes must be less than the LOD.

9.9. Dilution test (Serial Dilution)- A dilution test is performed to determine whether significant physical or chemical interferences exist due to the sample matrix. One sample per preparation batch must be processed as a dilution test. The test is performed by running a sample at a 5X dilution. Samples identified as field blanks cannot be used for dilution tests. The results of the diluted sample, after correction for dilution, should agree within 10% of the original sample determination when the original sample concentration is greater than 50X the IDL. If the results are not within 10%, the possibility of chemical or physical interference exists.

10. CALIBRATION

10.1. Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become stable before beginning calibration (approximately 30 minutes of warm-up is required). Refer to the facility specific

instrument SOP and CVAA instrument manual for detailed setup and operation procedures.

10.2. Calibration must be performed daily (every 24 hours) and each time the instrument is set up. The instrument calibration date and time must be included in the raw data.

10.3. Calibration standards must be processed through the preparation procedure as described in Section 11.

10.4. Calibrate the instrument according to instrument manufacturer's instructions, using a minimum of five standards. One standard must be at the reporting limit. Analyze standards in ascending order beginning with the blank. Calibration standards must be prepared fresh daily from the 0.1 mg/L intermediate standard (Section 7.6). The standards are made by addition of the intermediate standard to 24 mL of reagent water into 50 mL centrifuge tubes. Remove the spike volume from the 24 mL of reagent water before the addition of the intermediate standard. The calibration standard spike volumes and concentrations are as follows:

Calibration Standard Recipe					
Spike Volume (mL)	0.1	0.25	0.5	2.5	5.0
Concentration (ug/L)	0.2	0.5	1.0	5.0	10

Note: After addition of all reagents the final volume is 50 mL.

10.5. The calibration curve must have a correlation coefficient of ≥0.995 or the instrument shall be stopped and recalibrated prior to running samples. Sample results cannot be reported from a curve with an unacceptable correlation coefficient.

10.6. The initial calibration curve is immediately followed by analysis of the initial calibration verification standard (Section 9.7). The 2.0 mg/L ICV is made by adding 24 mL reagent water to a 50 mL centrifuge tube, withdrawing 1.0 mL reagent water, and adding 1.0 mL of 0.1 mg/L intermediate second source ICV standard.

10.7. The calibration is verified every 10 samples with a 5.0 mg/L CCV (Section 9.8) standard made the same way as the 5.0 mg/L calibration standard.

10.8. The autoclave is monitored daily to assure samples are digested for the proper time interval at the appropriate temperature. An "LASCAR" temperature logging device is put in the autoclave and undergoes the same program as the samples. This device can be connected to a computer and a program generates a graph of time vs temperature. These are submitted with the raw data.

10.9. For details of the calculations used to generate the linear regression, and how to use the factors generated by the linear regression, refer to SOP CA-A-S-005 "Calibration Curves (General)).

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. All preparation procedures must be carried out in a properly functioning hood.

11.3. All samples are to be checked out and back into sample control with the chain of custody documentation filled out completely. Samples are to be returned to the sample control area once all of the digestions have been initiated.

11.4. The proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be accurate and legible. Always set the samples up on the sample cart in the order with which they are to be dispensed. Double-check the sample bottle IDs, once prior to weighing them into the centrifuge tubes and before they are returned to the sample cart.

11.5. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/plant) are usually logged in with solid test codes. When initiating preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as a solid but appears more like a waste (biphasic, organic liquid, etc.) or is aqueous in nature contact the lab supervisor or project manager for further instructions. In some cases it may be more appropriate to process these samples as solids.

11.6. Always read the QAS for every project prior to establishing batch associations. This is meant to assure that all client requirements are satisfied and it also aids in creating more efficient batches. Setting up batches to minimize QC and meet all client requirements is a skill that must be developed by all new personnel with the aid of skilled sample preparation and analytical staff.

11.7. Sample Preparation:

11.7.1. All standards are processed through the same sample preparation procedure as field samples including the initial calibration, ICV, and CCVs.

11.7.2. Transfer approximately 0.6 g +/- 5% of **homogenized** sample to a 50 mL centrifuge tube. Refer to SOP WS-QA-0018 for the proper sub-sampling technique. To assure maximum representation of the matrix, take three aliquots of approximately 0.2 g from different areas of the solid material. Attempting to measure exact weights may cause bias relative to matrix distribution therefore all of the weights are approximate. Record the exact weights on the preparation log.

11.7.3. Weigh approximately 0.6g of Teflon® boiling chips into 50 mL centrifuge tubes for the MB and LCS.

11.7.4. Spike the LCS with 0.5 mL of the 0.1 mg/L calibration intermediate (Section 7.6). This is a level of 1.0 ug/L in the digestate, and equivalent to 0.083 mg/kg

11.7.5. Spike the MS/SD with 1.5 mL of the 0.1 mg/L calibration intermediate (Section 7.6). This is a level of 3.0 ug/L in the digestate, and equivalent to 0.25 mg/kg.

11.7.6. Add 24 mL of reagent water to all of the samples and the containers labeled for the blanks (MB, ICB, CCB). Add 23.5 mL of reagent water to the containers labeled for the LCS. Add 22.5 mL of reagent water to the containers labeled for the MS/SD.

11.7.7. Add 2.0 mL of concentrated HNO_3 and 5.0 mL of concentrated H_2SO_4 to all of the samples and standards.

11.7.8. Add 5.0 mL of potassium permanganate solution. For samples high in organic materials or chlorides, additional permanganate may be added. Shake and add additional portions of permanganate solution until a purple color persists for at least 15 minutes. If after the addition of 5.0 mL additional permanganate the color does not persist, sample dilution may be required.

***Note**: When reporting analyses, the addition of excess reagent must be addressed through mathematical correction of the results to account for the resultant dilution effect.*

11.7.9. Add 8.0 mL of potassium persulfate solution.

11.7.10. Autoclave all standards and samples for 15 minutes at 120 °C and 15 psi. Make sure the “ERTCO” temperature-logging device is programmed and accompanies all digestions.

11.7.11. Allow the autoclave to cool to less than 80°C where the psi reading is down to zero.

WARNING: Caution must be used when opening the door of the autoclave as superheated steam may be present and can cause significant burns.

11.7.12. The samples must be allowed to cool to room temperature prior to analysis or a decrease in the response signal can occur.

11.8. Sample Analysis:

11.8.1. When ready to begin analysis, add 6.0 mL of sodium chloride-hydroxylamine hydrochloride solution to all samples and standards to reduce the excess permanganate (the permanganate has been reduced when no purple color remains). Mercury analysis is run using either a Hydra AA or PS200II automated mercury analyzer. Results are reported as ug/kg of mercury.

11.8.1.1. Make certain the lamp is on and has been warmed up for a minimum of ½ hour.

11.8.1.2. Insert the line going into the injector rinse reservoir into the 10% HCl container. Insert the line going to the liquid-gas separator into the stannous chloride solution.

11.8.1.3. Adjust the stannous chloride, HCL rinse, and sample pump windings such that uptake is smooth and continuous with no pulsing. Make sure the waste pump windings are adjusted so there is no build up of liquid in the liquid-gas separator.

11.8.1.4. Load the samples into the automated sampler racks according to the sample lists entered into the computer. Do a final check once all samples have been loaded on to the racks to assure proper sequencing.

11.8.1.5. Begin the analysis.

11.8.2. Any samples with a concentration exceeding the highest calibration standard must be diluted with prepared blank solution such that the final result is within the range of the calibration curve.

11.8.3. If a sample result is negative and the absolute value of the negative result is greater than the reporting limit an interference should be suspected. Dilute the sample until it is less than the reciprocal of the reporting limit.

11.8.4. Baseline correction is acceptable as long as it is performed after every sample or after the CCV and CCB. Resloping is acceptable as long as it is immediately preceded and followed by a compliant CCV and CCB.

11.9. To facilitate the early identification of QC failures and samples requiring rerun it is strongly recommended that sample data is reviewed periodically throughout the run.

12. CALCULATIONS/DATA REDUCTION

12.1. ICV/CCV percent recoveries are calculated according to the equation:

$$\%R = 100\left(\frac{Found_{(ICV\ /\ CCV)}}{True_{(ICV\ /\ CCV)}}\right)$$

12.2. Matrix spike recoveries are calculated according to the following equation:

$$\%\ R\ =\ 100\left(\frac{SSR\ -\ SR}{SA}\right)$$

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

12.3. The relative percent difference (RPD) of matrix spike/matrix spike duplicates or sample duplicates are calculated according to the following equations:

$$RPD = 100\left[\frac{|MSD - MS|}{\left(\frac{MSD + MS}{2}\right)}\right]$$

Where:

MS = determined spiked sample concentration
MSD = determined matrix spike duplicate concentration

$$RPD = 100\left[\frac{|DU1 - DU2|}{\left(\frac{DU1 + DU2}{2}\right)}\right]$$

Where:

DU1 = Sample result
DU2 = Sample duplicate result

12.4. The final concentration for a soil sample is calculated as follows:

$$\mu g\ /\ Kg = C \times D \times \frac{0.05L}{W}$$

Where:

C = Concentration ($\mu g/L$) from instrument readout
D = Instrument dilution factor
W = Sample weight in Kg (0.006 Kg nominal)

12.5. The LCS percent recovery is calculated according to the following equation:

$$\%R = 100\left(\frac{Found_{(LCS)}}{True_{(LCS)}}\right)$$

12.6. Appropriate factors must be applied to sample values if dilutions are performed.

12.7. Sample results should be reported with up to three significant figures in accordance with the TestAmerica Sacramento significant figure policy (see WS-PQA-004, Rounding and Significant Figures).

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must

abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Acidic waste generated by the extraction and unused acidic digestate containing nitric and hydrochloric acid. This acidic liquid is consolidated into a plastic LLE drum in the H3 closet. When the drum is full, or after no more than 75 days, move it to the waste collection area for shipment.

15.2. Contaminated disposable materials such as plastic vials, pipettes, and filters used during sample preparation and digestion are dumped into a solid waste contaminated lab trash bucket. When the bucket is full, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full, or after no more than 75 days, move it to the waste collection area for shipment.

15.3. Expired standards and samples containing high levels of mercury are transferred to the waste collection area for proper disposal.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update II, Revision I, September 1994, Method 7471A (Mercury).

16.2. "Methods for the Chemical Analysis of Water and Wastes", EPA-600/4-79-020, U.S.EPA, 1974, Method 245.5, "Mercury in Sediment".

16.3. WS-PQA-003, Quality Control Program.

16.4. WS-PQA-004, Rounding and Significant Figures.

16.5. WS-QA-0006, Method Detection Limits and Instrument Detection Limits.

16.6. WS-QA-0023, Nonconformance and Corrective Action System.

16.7. WS-QA-0018, Sub-sampling

16.8. CA-Q-S-005, Calibration Curves (General)

17. METHOD MODIFICATIONS

17.1. Modification from Method 7471A and 245.5.

17.1.1. An autoclave is used for sample preparation rather than a hot plate (7471A) or water bath (245.5). See Appendix F. Use of the autoclave eliminates the need for addition of aqua regia.

17.1.2. The method has been modified for use with the Leeman automated analyzer. The samples are prepared to a total volume of 50 mL with reagents, versus the 100 mL volume specified in both methods. The addition of all reagents is modified relative to this decrease in volume. Stannous chloride in HCl is used in place of stannous sulfate in H_2SO_4 (per instrument instructions). The analytical method is automated, whereas both methods are written for manual CVAA analysis.

17.1.3. The five point curve used by STL Sacramento has a 17 µg /Kg (0.2 µg/L for water equivalent) standard to accommodate analysis of one standard at our 17 µg/Kg reporting limit. Both reference methods start with an 83 µg /Kg (0.5 µg/L for water equivalent) standard.

17.1.4. Both reference methods include a 167 µg/Kg (2 µg/L for water equivalent) mercury standard. We do not run a point at this level.

17.2. Modifications from previous SOP

17.2.1. The method has been modified for automated mercury analysis using a Leeman PS 200 CVAA mercury analyzer.

17.2.2. Stock standards are 10 µg/L mercury, not 1000 µg/L mercury.

17.2.3. A five point calibration curve is analyzed excluding the 167 µg /Kg (2 µg/L for water equivalent) mercury standard.

17.2.4. The “20X” method blank rule has been changed to “10X”.

17.2.5. The ICV recovery acceptance criteria in this SOP is +/- 10%, not +/- 20%.

17.3. Modifications from previous SOP – Revision 4.0

17.3.1. The safety section was modified to the accepted format from revision 3.0.

17.3.2. The Hydra AA instrument was added to the equipment list.

17.3.3. Deleted details of instrumentation not necessary in this SOP.

17.3.4. Added 14 mL test tubes (autosampler tubes) to the equipment list.

17.3.5. Eliminated Class A volumetric pipettes from the equipment list.

17.3.6. Standards: Added the 10 mg/L stock solution and 0.1 mg/L intermediate standard for the second source.

17.3.7. ICV spiking detail was added to the “Calibration and Standardization” section.

17.3.8. LCS/MS/SD spiking detail was added to the “Procedure” section.

17.3.9. 10% rinse solution added to this SOP.

17.3.10. All reagents modified to reflect the actual final volumes made by the laboratory.

17.3.11. The “Quality Control” section was reformatted to comply with the more generic version used in current SOPs.

17.3.12. The initial seven sections of the “Procedure” section comply with more detailed instructions of sample preparation.

17.3.13. SOP SAC-QC-0018 was added to assure analysts use proper sub-sampling procedures.

17.3.14. Spiking is not done after the addition of acids, but prior to the addition of acids.

17.3.15. The “Method Performance” section was updated.

17.3.16. The “Pollution Prevention” section was updated.

17.3.17. The “Waste Management” section was updated.

17.3.18. Table I: “Summary of Quality Control Requirements” was removed.

18. ATTACHMENTS

18.1. Appendix 1, Contamination Control Guidelines

18.2. Appendix 2, Autoclave Usage Letter

19. REVISION HISTORY

19.1. WS-MT-0007, Revision 5.2, Effective 01/20/2012

19.1.1. Section 6.14: added “Teflon® boiling chips”.

19.1.2. Section 11.7.3: added “Weigh approximately 0.6g of Teflon® boiling chips into 50 mL centrifuge tubes for the MB and LCS.”

19.2. WS-MT-0007, Revision 5.1, Effective 10/19/2009

19.2.1. Revised Section 6.2 to read, “Automated mercury analyzers: Leeman PS200II and HydraAA (or equivalent) both with autosamplers and WinHg software (or equivalent).

19.2.2. Revised Section 11.7.2 to read, “Transfer approximately 0.6 g +/- 5% of **homogenized** sample to a 50 mL centrifuge tube. Refer to SOP WS-QA-0018 for the proper sub-sampling technique. To assure maximum representation of the matrix, take three aliquots of approximately 0.2 g from different areas of the solid material. Attempting to measure exact weights may cause bias relative to matrix distribution therefore all of the weights are approximate. Record the exact weights on the preparation log.”

19.2.3. Revised Section 11.7.3 to read, “Spike the LCS with 0.5 mL of the 0.1 mg/L calibration intermediate (Section 7.6). This is a level of 1.0 ug/L in the digestate, and equivalent to 0.083 mg/kg.”

19.2.4. Revised Section 11.7.4 to read, “Spike the MS/SD with 1.5 mL of the 0.1 mg/L calibration intermediate (Section 7.6). This is a level of 3.0 ug/L in the digestate, and equivalent to 0.25 mg/kg.”

19.2.5. Revised Section 11.7.5 to read, “Add 24 mL of reagent water to all of the samples and the containers labeled for the blanks (MB, ICB, CCB). Add 23.5 mL of reagent water to the containers labeled for the LCS. Add 22.5 mL of reagent water to the containers labeled for the MS/SD.”

19.3. WS-MT-0007, Revision 5, Effective 08/26/2009

19.3.1. Updated to TestAmerica format.

19.3.2. Editorial changes.

APPENDIX I
CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross-contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

APPENDIX II
AUTOCLAVE USAGE LETTER

Ms. Debra K. White
Principal Inorganic Scientist
Quanterra Incorporated
4955 Yarrow Street
Arvada, CO 80002

Dear Deb,

Thank you for your letters of July 10, 1995 and September 25, 1995, seeking clarification on several issues regarding RCRA testing and analysis. As the Office of Solid Waste updates SW-846 methods, we will take every opportunity to incorporate your comments and suggestions. Our goal is to remove overly restrictive language from SW-846 methods, which does not effect method performance and to continue to move toward truly performance based methods.

Your first request is for a clarification regarding the acceptance of the autoclave to prepare aqueous samples for mercury analysis under EPA SW-846 Method 7470A. The heating device in Section 4.10 of the Method 7470A specifies "Hot plate or equivalent." An autoclave would classify as an equivalent heating device and should give equivalent results to the hot plate/water bath protocol called for in Sections 7.1 and 7.2 of Method 7470A. Method 245.1 CLP-M is analogous to Method 7470A and allows the autoclave option for sample preparation.

Your second request is for a clarification regarding scaling of sample size for RCRA analysis. In particular, you request processing 50 mL aliquots for aqueous metal digestion rather than the 100 mL sample size specified in the methods. This should not present any problems for pure aqueous samples (no solids) because of their homogeneous nature. As a "representative sample" can be assured, scaling causes no loss of precision or accuracy in the analysis. Solid samples on the other hand are frequently heterogeneous in nature and changing sample size presents a big problem in obtaining a "representative sample" and should not be allowed without proper sample preparation (ie. crushing, grinding, mixing, and splitting).

I hope that this information is helpful to your analytical program. If you have any questions, please feel free to call me at (202) 260-4778.

Sincerely,

Oliver M. Fordham, Jr.

National Inorganic Program
Manager for RCRA

Title: Extraction of Semivolatile Organic Compounds for Analysis by Method 8270C, Based on SW-846 3500 Series and 3600 Series, and PAH-SIM by Internal Standard and Isotope Dilution Procedures

[Method 8270C]

Approvals (Signature/Date):

Elizabeth Nguyen — 4/16/12
Technical Manager — Date

Joe Schairer — 4/16/12
Health & Safety Manager / Coordinator — Date

Douglas Weir — 4/16/12
Quality Assurance Manager — Date

Karla Buechler — 4/16/12
Laboratory Director — Date

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1. SCOPE AND APPLICATION

This SOP describes procedures for preparation (extraction and concentration) of semivolatile organic analytes in aqueous, TCLP leachate, soil and waste matrices for analysis by Gas Chromatography/Mass Spectrometry (GC/MS). The procedures are based on SW-846 and are applicable for measurements made to comply with the Resource Conservation and Recovery Act (RCRA).

1.1. Extraction procedures for the following determinative methods are covered: 8270C and 8270C (modified). 8270C (modified) encompasses analysis for 1,4-Dioxane, PAHs by Selected Ion Monitoring (PAH-SIM), and PAHs by Selected Ion Monitoring-Isotope Dilution (PAH-SIM-ID). The extraction procedures here may be appropriate for other determinative methods when appropriate spiking mixtures are used.

1.2. Other extraction procedures (PFE, SPE, accelerated Soxhlet, etc.) may be used but are not currently covered in this SOP.

1.3. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Separatory Funnel Extraction: A measured volume of sample, typically 1 liter, is adjusted, if necessary, to a specified pH and serially extracted with methylene chloride using a separatory funnel.

2.2. Continuous Liquid/Liquid Extraction: A measured volume of sample, typically 1 liter, is placed into a continuous liquid/liquid extractor, adjusted, if necessary, to a specific pH and extracted with methylene chloride for 18-24 hours.

2.3. Sonication Extraction: A measured weight of sample, typically 30 g, is mixed with anhydrous sodium sulfate to form a free flowing powder. This is solvent-extracted three times using an ultrasonic horn.

2.4. Soxhlet Extraction: A measured weight of sample, typically 15 g, is mixed with anhydrous sodium sulfate to form a free flowing powder. This is extracted with refluxing solvent for 16-24 hours.

2.5. Concentration: Procedures are presented for drying and concentrating the extracts to final volume for analysis.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.2. Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

4.3. To prevent analyte loss, extracts which are not immediately concentrated by KD must be protected from light during storage. Extracts may be either refrigerated or stored in an opaque container.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex and vinyl gloves provide no protection against most of the organic solvents used in this method. Nitrile gloves must be used. Latex gloves may be used for methanol.

5.1.2. The use of solvent dispensing pumps and solvent squeeze bottles are high risk activities, and a face shield must be worn over safety glasses or goggles while using a dispensing pump.

5.1.3. Exposure to chemicals must be maintained **as low as reasonably achievable**; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.4. When Soxhlet /CLLE extractions are performed overnight or unattended, special precautions must be taken. Open the chiller valves to the system about 15 minutes before the heating elements are turned on, and check every condenser to ensure that it is cold and functioning properly before turning the heating elements on. Check every condenser again about 15 minutes after turning the heating elements on to ensure that they are still cold and functioning properly. If the system is left operating overnight or unattended for an extended period, the first chemist to come back into the lab must again check every condenser to ensure that it is still cold and functioning properly.

5.1.5. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.6. The use of separatory funnels to extract aqueous samples with methylene chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the sample container has been sealed and inverted. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity, and a face shield must be worn over safety glasses or goggles when it is performed. Alternately, the process may be performed behind a closed fume hood sash.

5.1.7. The use of ultrasonic sonicator systems to extract soil samples creates a hazard to hearing. Sonication must be performed inside of a fume hood, with all sashes on the hood closed. The operator must wear hearing protection while the sonicators are functioning.

5.1.8. Assembly and disassembly of glassware, including stopcocks and stoppers, creates a risk of breakage and cuts. All staff members shall wear Kevlar® or similar cut-resistant gloves over chemically resistant gloves when assembling and disassembling glassware.

5.1.9. The use of vacuum systems during rotovap concentration presents the risk of imploding glassware. All glassware used during vacuum operations must be

thoroughly inspected prior to each use. Glass that is chipped, scratched, cracked, rubbed or marred in any manner must not be used under vacuum. It must be removed from service and replaced.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sodium Hydroxide	Corrosive	2 Mg/M3-Ceiling	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.

Sulfuric Acid (1)	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 Mg/M3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Glassware should be cleaned with soap and water, rinsed with water and dried in an oven at 400°C for at least 2 hours. Refer to SOP WS-OP-0011 for details of glassware cleaning. Kilned glassware does not require solvent rinsing before use.

WARNING: Heat resistant gloves must be used when handling kilned glassware.

6.2. Equipment and supplies for extraction procedures

6.2.1. Separatory funnel, 2L

6.2.2. Separatory funnel rotator

6.2.3. Balance: >1400 g capacity, accurate ±1 g

6.2.4. pH indicator paper, wide-range: covers extraction pH

6.2.5. Graduated cylinder: 1 liter. (Other sizes may be used)

6.2.6. Erlenmeyer flask, beaker, or French Square jar: 125 & 300 mL (other sizes optional)

6.2.7. Solvent dispenser pump or 100 mL graduated cylinder

6.2.8. Continuous liquid/liquid extractor

6.2.9. Round or flat bottom flask: 250, 500 mL or 1 L

6.2.10. Boiling chips: Contaminant free, approximately 10/40 mesh (Teflon® PTFE, carbide or equivalent).

6.2.11. Cooling condensers

6.2.12. Heating mantle: Rheostat controlled, with timer

6.2.13. Beakers: 250 & 400 mL, graduated

6.2.14. Balance: >100 g capacity, accurate to ±1g

6.2.15. Soxhlet extractor

6.2.16. Sonicator (at least 300 watts), with sonicator horn, 3/4 inch. Preventive and routine maintenance is described in the "Schedule of Routine Maintenance" in the QAM, Preventative Maintenance (Section 20.2) and Schedule of Routine Maintenance (Table 20.2).

6.2.17. Kuderna-Danish (KD) apparatus: 500 mL, with 10mL concentrator tube, and 3-ball macro Snyder Column

6.2.18. Locally assembled solvent vapor condensing/recovery system for use with 6.2.17 above.

6.2.19. Water bath: Heated, with concentric ring cover, capable of temperature control (± 5°C) up to 95°C. The bath must be used in a hood or with a solvent recovery system.

6.2.20. Nitrogen blowdown apparatus.

6.2.21. Culture tubes: 10 mL, 16 mm x 100 mm

6.2.22. Syringe: 1 mL

6.2.23. Glass wool

6.2.24. Glass funnel: 75 X 75 mm

6.2.25. Disposable pipets

6.2.26. Aluminum foil

6.2.27. Paper towels

6.2.28. 60 mL VOA vial w/ teflon lined caps

7. REAGENTS AND STANDARDS

7.1. Reagents for Extraction Procedures

All reagents must be ACS reagent grade or better unless otherwise specified.

7.1.1. Sodium hydroxide solution, 10 N, reagent grade

7.1.2. Sulfuric acid (H_2SO_4), concentrated; reagent grade

7.1.3. Sulfuric acid (1:1): Carefully add 500 mL of H_2SO_4 to 500 mL of reagent water. Mix well.

WARNING: Always add concentrated acids or bases to water, never add water to the concentrated acid or base solution.

7.1.4. Organic free reagent water. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks, in accordance with SOP WS-QA-0014, "Monitoring of Reagent-Grade Laboratory Water.

7.1.5. Sodium sulfate (Na_2SO_4), granular, anhydrous: Purify by heating at 400°C a minimum of two hours.

7.1.6. Extraction/exchange solvents: Methylene chloride, pesticide quality or equivalent, and 1:1 methylene chloride:acetone.

7.1.7. Acetone: Used for cleaning

7.1.8. Nitrogen, reagent grade

7.2. Reagents for Cleanup Procedures

7.2.1. Oasis HLB Extraction Cartridge: 500 mg pre-packed in 6mL cartridges with polyethylene frits (Waters part # 186000115, or equivalent).

7.2.2. Activated Silica Gel: Activate for at least 1 hour at 190degC (+/- 5deg). Store at 130-200 deg C in a covered glass container.

7.3. Standards

7.3.1. Stock Standards

Stock standards are purchased as certified solutions or prepared from neat materials. Semivolatile stock standards are stored in a freezer at ≤ 0ºC. All stock standards must be protected from light.

7.3.1.1. Stock standard solutions must be replaced after one year (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Standards must be allowed to come to room temperature before use.

7.3.1.2. Expired standards must be rotated out of the lab to the Hazardous Waste storage area.

7.3.2. Surrogate Spiking Standards/Isotope Dilution Internal Standards

Prepare or purchase surrogate spiking standards at the concentrations listed in Tables 2 and 4. Surrogate spiking standards are prepared as dilutions of the stock standards. Surrogate spiking solutions must be refrigerated and protected from light. The standards are given a one year expiration date from the time of preparation, or the expiration date of the stock solution, whichever is sooner. Standards may be replaced sooner if there is reason to believe that the standard has degraded or concentrated.

7.3.3. Matrix Spiking and Laboratory Control Spiking Standards.

The same spiking solution is used for the matrix spike (MS) and the laboratory control sample (LCS). Prepare MS/LCS spiking standards at the concentrations listed in Tables 1, 3, 5, and 6. Spiking standards are purchased or prepared as dilutions of the stock standards. Spiking solutions must be refrigerated and protected from light. The standards are given a one year expiration date from the time of preparation, or the expiration date of the stock solution, whichever is sooner. Standards may be replaced sooner if there is reason to believe that the standard has degraded or concentrated.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Samples are not chemically preserved.

8.2. Samples are stored at 4 ± 2°C in glass containers with Teflon®-lined caps.

8.3. Holding Times

8.3.1. Extraction is initiated within 7 days of the sampling date for aqueous samples, 14 days for solid and waste samples.

8.3.2. For TCLP leachates, extraction is initiated within seven days from when the leaching procedure is initiated.

8.3.3. Analysis of the extracts is completed within forty days of extraction.

9. QUALITY CONTROL

9.1. Quality Control Batch

The batch is a set of up to 20 field samples that are of the same matrix and are processed together using the same procedures and reagents. The batch must contain a method blank, an LCS and a matrix spike/matrix spike duplicate. (In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD). If clients specify specific samples for MS/MSD, the batch may contain multiple MS/MSDs. See policy WS-PQA-003 for further definition of the batch.

9.2. Insufficient Sample

If insufficient sample is available to process a MS/MSD, then a second LCS may be processed, if precision data is required by the client. The LCS pair is then evaluated according to the MS/MSD RPD criteria. Use of a LCS pair in place of a MS/MSD must be documented using Clouseau.

9.3. Method Blank

A method blank consisting of all reagents added to the samples must be prepared and analyzed with each batch of samples. Surrogates are spiked into the method blank at the same level as the samples. The method blank is used to identify any background interference or contamination of the analytical system, which may lead to the reporting of elevated concentration levels or false positive data.

9.3.1. Aqueous method blanks use 1000 mL of reagent water spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.3.2. Solid method blanks use 30 g of sodium sulfate spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.3.3. TCLP method blanks use 200 mL of leachate fluid spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.3.4. Method blanks for waste dilution procedures consist of the solvent used to dilute the sample, spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.4. Laboratory Control Sample (LCS)

Laboratory Control Samples are well-characterized, laboratory generated samples used to monitor the laboratory's day to day performance of routine analytical methods. The LCS, spiked with a group of target compounds representative of the method analytes, is used to monitor the accuracy of the analytical process, independent of matrix effects. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision. The LCS goes through the entire analytical procedure, including any cleanup steps.

9.4.1. The LCS is made up in the same way as the method blank (see Sections 9.3.1 - 9.3.4) but is spiked with the LCS standard and the surrogates.

9.5. Surrogates

9.5.1. Surrogates are organic compounds which are similar to the target analyte(s) in

chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.

9.5.2. Each applicable sample, blank, LCS and MS/MSD is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining whether the concentration (measured as percent recovery) falls within the required recovery limits.

9.5.3. In the case of the PAH-SIM-ID analysis, LCS spikes are equivalent to native standards, (N.S.),for the purposes of this SOP.

9.6. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike is an environmental sample to which known concentrations of target analytes have been added. A matrix spike duplicate is a second spiked aliquot of the same sample, which is prepared and analyzed along with the sample and matrix spike.

9.7. Initial Demonstration of Capability

The initial demonstration and method detection limit studies described in Section 13 must be acceptable before analysis of samples may begin.

9.8. Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries (QAS) should be developed to address these requirements.

9.9. TestAmerica West Sacramento QC Program

Further details of QC and corrective action guidelines are presented in the TestAmerica West Sacramento QC Program document (WS-PQA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION

10.1. On the day of use, measure either 0.5 mL or 1.0 mL of solvent into an autovial using a gastight syringe that is manufactured to a certified volume delivery tolerance of ±0.01 mL (1 mL total volume). The “standard” autovial is sealed. The autovials containing the sample extracts are then compared against the “standard” vial to ensure that the final volume is consistently 1.0 ± 0.01 mL. If a new box of autovials is used, then the steps are repeated to further ensure that variations due to vial size and shape are minimized.

10.2. On a monthly basis, calibrate any auto-pipettors to be used in accordance with SOP WS-QA-0004.

10.3. On the day of use, calibrate any balances to be used in accordance with SOP WS-QA-0041.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Separatory Funnel Liquid/Liquid Extraction of Water Samples.

11.2.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.2.1.1. If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.
b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.
c) Processing the aqueous portion as described in a) along with creating a new sample id for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to create a second extract for the sample that is to be added to the extraction batch of water samples

NOTE: In the case of option "b", after adding the appropriate surrogates/spikes, the sample would be gently swirled for mixing purposes and then gently poured into the separatory funnel, thus minimizing the amount of sediment transferred to the extraction vessel during the process. The original sample container would then be

rinsed with 60 mL of DCM. This DCM rinseate would then be poured into the extraction vessel.

11.2.2. Measure the initial sample pH with wide-range pH paper by dipping a disposable pipette into the sample and wetting the pH paper. Record on the extraction benchsheet. If sample is a leachate (e.g. TCLP), compare the current pH against the leachate log and note on the benchsheet if there is any discrepancy.

11.2.3. The normal sample volume is 1 liter. Other sample volumes may be used to obtain specific reporting limits, and reduced sample volumes, diluted to 1 liter with reagent water, may be used for very dirty samples.

11.2.4. Weigh the sample container on a balance (± 1 g), taring the sample and container. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples.

Test	Surrogate Solution		Matrix Spike Solution	
	Volume	Name	Volume	Name
8270C	0.5 mL	8270 Surrogate	1.0 mL	8270 Spike 100 ug/mL
1,4-Dioxane	50 µL	8270 Surrogate	50 µL	1,4-Dioxane
PAH-SIM	0.5 mL	PAH Surrogate	0.5 mL	PAH Spike Mix
PAH-SIM-ID	0.10 mL	PAH-IS	0.05 mL	PAH-ID N.S.

Note: Contents of each solution are described in the tables in Section 17.

11.2.5. Mix well, or if the sample contains sediment, decant before transfer. Transfer the sample to the separatory funnel. Rinse the sample bottle with 60 mL methylene chloride and transfer to the separatory funnel. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

Note: *If the sample bottle is completely full, it may be difficult to add the spike solutions to the bottle. In this case, transfer part of the sample to the separatory funnel and then add the spike to the bottle.*

WARNING: Methylene chloride creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the sample container has been sealed and inverted. Vent into hood away from analysts and other samples.

11.2.5.1. If the entire sample bottle will not be used, measure an aliquot using a graduated cylinder, then transfer the aliquot to the separatory funnel, and then add the spiking solutions to the sample in the separatory funnel.

Note: *Alternative methods of measurement of sample volume include a) transferring the sample to a measuring cylinder and b) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.*

11.2.6. For TCLP samples, Use 200 mL of leachate measured in a graduated cylinder. Dilute the leachate to approximately 1 L with reagent water. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples. Add 60 mL of methylene chloride to the separatory funnel.

11.2.7. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP. Use 1 L of reagent water for method blanks and LCS. The LCS is spiked with the surrogate and matrix spike solutions, the method blank only with the surrogates. See Section 11.2.4 for spiking solutions and volumes.

11.2.8. TCLP samples should be prepared in their own batch. For a TCLP batch prepare a reagent blank as in the Section 11.2.7 above. In addition, prepare a TCLP method blank by measuring 200 mLs of buffer solution used in the leaching procedure and transfer to the separatory funnel. Dilute the leachate to approximately 1L with reagent water. No leachate LCS is required by this method.

11.2.9. For regular 8270C samples, adjust sample pH to between 1 and 2. Use the minimum amount of 1:1 H_2SO_4 necessary. Recheck the sample with pH paper by dipping a disposable pipette into the sample and wetting the pH paper.

Note: *Samples for PAH-SIM, PAH-SIM-ID and 1,4-Dioxane analysis are extracted at neutral pH (pH 5 – pH 9). These samples should not require pH adjustment.*

11.2.10. Record adjusted pH, spiking volumes standard numbers, and reagent lots on the benchsheet. Return spiking solutions to the refrigerator as soon as possible.

11.2.11. Seal and shake or rotate the separatory funnel vigorously for 2 minutes with

periodic venting to release excess pressure.

WARNING: Methylene chloride creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the separatory funnel has been sealed and inverted. Vent into hood away from analysts and other samples.

11.2.12. Allow the organic layer to separate from the water phase until complete visible separation has been achieved (at least 10 minutes). If the emulsion interface between layers is more than one-third the size of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods. If the emulsion cannot be broken (recovery of <80% of the methylene chloride*), transfer the sample, solvent, and emulsion into the extraction chamber of a continuous extractor and proceed as described in continuous liquid-liquid extraction (Section 11.3.). If this is done, the sample must be extracted as part of a valid CLLE batch.

***Note:** 15 – 20 mL of methylene chloride is expected to dissolve in 1 L of water. Thus, solvent recovery could be as low as 40 mL from the first shake and still be acceptable. Subsequent shakes should recover at least 50 mL of solvent.*

11.2.13. Fill a funnel with 10-20 g of anhydrous sodium sulfate. The funnel can be plugged with glass wool or filter paper may be used to hold the sodium sulfate. Rinse the funnel with a small amount of methylene chloride, and discard the rinsate. Drain the solvent extract from the separatory funnel through the prepared filtration funnel into a clean glass container. The extract may be drained directly into the KD flask. Close the stopcock just before the water level begins draining out of the separatory funnel. If the sodium sulfate becomes saturated with water add more to the funnel or replace the existing sodium sulfate with fresh drying agent.

11.2.14. Repeat the extraction process two more times using fresh 60 mL portions of solvent, combining the three solvent extracts in the collection container. If extraction at a secondary pH is not required, proceed to Section 11.2.16.

11.2.15. If extraction at a secondary pH is required, adjust the pH of the sample in the separatory funnel to between 11 and 12 with a minimum amount of 10 N NaOH. Measure with pH paper and record the adjusted pH on the benchsheet. Serially extract with three 60 mL portions of methylene chloride, as outlined in Sections 11.2.11 to 11.2.14. Collect these three extracts in a separate bottle.

11.2.16. Rinse the extract residue from the sodium sulfate by pouring 20-30 mL of

clean methylene chloride through the funnel and into the collection container.

11.2.17. Dispose the solvent-contaminated water remaining in the extractor into the LLE waste drum. Waste methylene chloride goes to the solvent waste drum for recycling.

11.2.18. If the extract is not concentrated immediately, refrigerate it to protect from light. Alternatively, the extract bottle may be wrapped with foil to protect from light for short periods of time (i.e., overnight). Refer to Section 11.8 for concentration.

11.3. Continuous Liquid/Liquid Extraction from Water Samples.

11.3.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.3.1.1. If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.
b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.
c) Processing the aqueous portion as described in a) along with creating a new sample id for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to create a second extract for the sample that is to be added to the extraction batch of water samples

NOTE: In the case of option "b", after adding the appropriate surrogates/spikes, the sample would be gently swirled for mixing purposes and then gently poured into the separatory funnel, thus minimizing the amount of sediment transferred to the extraction v vessel during the process. The original sample container would then be rinsed with 60 mL of DCM. This DCM rinseate would then be poured into the extraction vessel.

11.3.2. Assemble the apparatus as shown in Figure 1. Add 300-500 mL of methylene chloride to the extractor body. Add 3 to 5 boiling chips to the round-bottom distilling flask.

11.3.3. Measure the initial sample pH with wide-range pH paper and record on the extraction benchsheet. If sample is a leachate (e.g. TCLP), compare the current pH against the leachate log, and note on the benchsheet if there is any discrepancy.

11.3.4. Weigh the sample container on a balance (± 1 g), taring the sample and container. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples. Mix well. Transfer the sample to the extractor. Rinse the sample bottle with 60 mL methylene chloride and transfer to the extractor. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

Test	Surrogate Solution		Matrix Spike Solution	
	Volume	Name	Volume	Name
8270C	0.5 mL	8270 Surrogate	1.0 mL	8270 Spike
1,4-Dioxane	50 µL	8270 Surrogate	50 µL	1,4-Dioxane
PAH-SIM	0.5 mL	PAH Surrogate	0.5 mL	PAH Spike Mix
PAH-SIM-ID	0.10 mL	PAH-IS	0.05 mL	PAH-ID N.S.

Note: Contents of each solution are described in the tables in Section 17.

Note: *If the sample bottle is completely full, it may be difficult to add the spike solutions to the bottle. In this case, transfer the sample to the extractor and then add the spike.*

11.3.4.1. If the entire sample bottle will not be used, transfer the aliquot to the extractor, then add the spiking solutions to the sample in the extractor.

Note: *Alternative methods of measurement of sample volume include: a) transferring the sample to a measuring cylinder and b) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.*

11.3.4.2. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP. Use 1 L of reagent water for method blanks and LCS. The method blank is spiked with the surrogates, the LCS and matrix spikes with the surrogates and matrix spiking solutions.

11.3.4.3. Use 200 mL of leachate for TCLP semivolatiles, measured in a graduated cylinder. Dilute to about 1 liter with reagent water.

11.3.4.4. For a TCLP method blank, measure 200 mL of the buffer solution

used in the leaching procedure. Dilute to about 1 liter with reagent water.

11.3.5. Less than one liter of sample may be used, for highly contaminated samples, or if the reporting limit can be achieved with less than one liter of sample. In this event dilute the sample to about 1 liter with reagent water. For regular 8270C samples, adjust sample pH to between 1 and 2. Use the minimum amount of 1:1 H_2SO_4 necessary. Recheck the sample with pH paper by dipping a disposable pipette into the sample and wetting the pH paper.

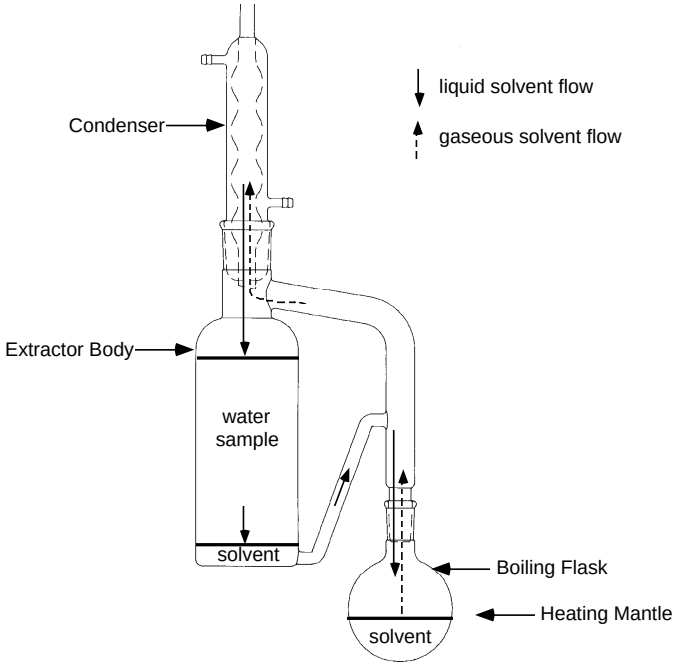
Note: *Samples for PAH-SIM, PAH-SIM-ID, and 1,4 Dioxane analysis are extracted at a neutral pH (pH 5 – pH 9). These samples should not require pH adjustments.*

11.3.6. Add reagent water to the extractor body until approximately 250 mL of methylene chloride is pushed over into the round-bottomed flask to ensure proper operation and solvent cycling. Attach cold condenser (about 12°C). Turn on heating mantle. Inspect joints for leaks once solvent has begun cycling. Extract for 18-24 hours. If extraction at a secondary pH is not required, proceed to 11.3.8.

WARNING: Open the chiller supply valves about 15 minutes before turning on the heating element and ensure that all of the condensers are cold before you turn the heating element on. Check all of the condensers about 15 minutes after starting the heating process to ensure that they are still cold and functioning properly. If this cleaning cycle is to be left unattended (e.g. overnight) the first chemist to arrive the next morning is to check all condensers to ensure that they are still cold and functioning properly.

11.3.7. If extraction at a secondary pH is required, turn off the heating mantle and allow the extractor to cool. Detach the condenser and adjust the pH of the sample in the extractor body to between pH 11 and pH 12 with a minimum amount of 10 N NaOH. Measure with pH paper and record the adjusted pH on the benchsheet. If desired, the acid and base fractions may be kept separate by replacing the boiling flask with a clean flask and fresh solvent. Reattach the condenser and turn on heating mantle. Extract for 18-24 hours.

Figure 1, LLE Setup (See Section 11.3.1 for description)



11.3.8. Turn off the heating mantle and allow the extractor to cool.

11.3.9. Place a funnel containing 10-20 g of anhydrous sodium sulfate on the Kuderna-Danish (KD) apparatus or other glass container. The funnel can be plugged with glass wool enabling it to hold the granular anhydrous sodium sulfate or phase separation filter paper may be used. Use a small amount of methylene chloride to rinse the funnel and sodium sulfate, discard the rinsate.

11.3.10. Dry the extract in the round bottom flask by filtering it through the sodium sulfate-filled funnel. Note that it is not necessary or advisable to attempt to add the solvent remaining in the continuous extractor body to the extract.

11.3.11. Collect the dried extract in a KD or other glass container. Rinse the flask, which contained the solvent extract with 20-30 mL of methylene chloride and pour it through the funnel to complete the quantitative transfer. Dispose of solvent and water remaining in the extractor to the LLE waste drum. Waste methylene chloride goes to the DCM drum for recycling.

Note: *Some types of CLLE apparatus have built in drying columns. If this type of apparatus is used then a drying step subsequent to the extraction may not be necessary.*

11.3.12. If the extract is not concentrated immediately, refrigerate it to protect from light. Alternatively, the extract bottle may be wrapped with foil to protect from light for short periods of time (i.e., overnight). Refer to Section 11.8 for

concentration.

11.4. Microextraction for Water Samples

11.4.1. Remove surrogate and matrix spiking solutions from refrigerator and warm to room temperature.

11.4.2. The normal sample size is 40mL.

11.4.3. Weigh the sample container on a balance (± 1 g), taring the sample and container. Add 500µL of PAH 0.5µg/L spiking solution. Also add 80.0µL of 0.5µg/L PAH matrix spiking solution to any matrix spike/matrix spike duplicate samples.

11.4.4. Mix well, or if the sample contains sediment, decant before transfer. Transfer the sample to the 60 mL VOA. Rinse the sample bottle twice with 5 mL aliquots of methylene chloride and transfer to the 60mL VOA. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

11.4.5. Shake the VOA by hand for 5 minutes. Transfer as much of the DCM layer as possible to a 8mL screw cap test tube containing 2g of anhydrous sodium sulfate pre-weighed in the test tube.

NOTE: Be careful to minimize the amount of water transferred to the 8mL test tube.

11.4.6. Shake the test tube for 2 minutes to eliminate any residual water in the sample. If water is still visible, shake the sample again with additional sodium sulfate and then proceed to Section 11.8.4.

11.5. Sonication

11.5.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room, temperature.

11.5.2. Decant and discard any water layer on the sediment/soil sample. Homogenize the sample by mixing thoroughly. Discard any foreign objects such as sticks, leaves and rocks, unless the client requires extraction of this material. If the sample consists primarily of foreign materials consult with the client (via the Project Manager or Administrator). Document if a water layer was discarded.

11.5.3. Weigh 30 g of sample ± 1.0 g into a 250 mL beaker, 400 mL beaker or glass jar of sufficient size that the sodium sulfate and extraction solvents can be added. Record the weight to the nearest 0.1 g in the appropriate column on the benchsheet. Use 30 g of sodium sulfate for the method blank and LCS.

For PAH-SIM and PAH-SIM-ID analysis, use 10g of sample instead of 30 g of sample.

11.5.4. Mix weighed sample with a spatula adding enough anhydrous sodium sulfate (approximately 30 g) to be free flowing. (If the sample is not free flowing extraction efficiency may be reduced)

11.5.5. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP.

11.5.6. Add the surrogate spiking solution to each sample, method blank, laboratory control sample (LCS), and matrix spikes. Add the appropriate matrix spiking solution to each matrix spike/matrix spike duplicate (MS/MSD) and LCS. Record spiking volumes and standard numbers on the benchsheet. Return spiking solutions promptly to refrigerator.

Test	Surrogate Solution		Matrix Spike Solution	
	Volume	Name	Volume	Name
8270C	0.5 mL	8270 Surrogate	1.0 mL	8270 Spike
PAH-SIM	0.5 mL	PAH Surrogate	0.5 mL	PAH Spike Mix
PAH-SIM-ID	0.10 mL	PAH-IS	0.05 mL	PAH-ID N.S.

Note: Contents of each solution are described in the tables in Section 17.

Note: *The same volume of surrogate and matrix spiking solution is used if GPC is indicated since the final volume would be reduced to compensate for loss of extract during the GPC procedure.*

11.5.7. Immediately add a minimum of 60-100 mL of 1:1 methylene chloride:acetone to the beaker. (This should be enough to cover the soil and immerse the horn tip as noted in 11.5.9, below).

Note: *Steps 11.5.5 - 11.5.7 should be performed rapidly to avoid loss of the more volatile extractables.*

Note: *For PAH extractions, use DCM only.*

11.5.8. Make sure that all sonicator horns have been cleaned prior to sonicating. To achieve a clean sonicator horn, immerse each sonicator horn in a tri-pour beaker of de-ionized (DI) water for 2-3 pulses. Immediately rinse the horns with acetone to remove any excess water. Finish by rinsing each horn with dichloromethane (DCM). Sonicators are ready for use.

11.5.9. Place the bottom surface of the appropriate disrupter horn tip approximately ½ inch below the surface of the solvent, but above the sediment layer.

11.5.10. Sonicate for 3 minutes, making sure the entire sample is agitated. If the W-380 or W-385 sonicator is used the output should be set at 6 for the 3/4 inch high gain (Q) horn or 10 for the 3/4 inch standard horn with mode switch on

pulse, and percent-duty cycle knob set at 50%.

Note: *Do not use Microtip probe.*

WARNING: Hearing protection is required when sonicating samples.

11.5.11. Loosely plug the stem of a 75 mm x 75 mm glass funnel with glass wool and/or line the funnel with filter paper. Add 10-20 g of anhydrous sodium sulfate to the funnel cup.

11.5.12. Place the prepared funnel on a collection apparatus (beaker or KD).

11.5.13. Decant and filter extracts through the prepared funnel into a clean beaker or KD.

11.5.14. Repeat the extraction two more times with additional 60-100 mL minimum portions of solvent each time. Decant and retain the extraction solvent after each sonication. On the final sonication pour the entire sample (sediment and solvent) into the funnel and rinse with an additional 10 mL-20 mL of the methylene chloride/acetone.

11.5.15. If the extract is not concentrated immediately, refrigerate it to protect from light. Alternatively, the extract bottle may be wrapped with foil to protect from light for short periods of time (i.e., overnight). Refer to Section 11.7 for concentration.

11.5.16. Sonicator Tuning.

11.5.16.1. Tune the sonicator according to manufacturer's instructions. The sonicator must be tuned at least every time a new horn is installed.

11.6. Soxhlet

11.6.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.6.2. Decant and discard any water layer on the sediment/soil sample. Remove the top layer (1/2 inch) and homogenize the sample by mixing thoroughly. Discard any foreign objects such as sticks, leaves and rocks, unless the client requires extraction of this material. If the sample consists primarily of foreign materials consult with the client. Document on benchsheet if a water layer was discarded.

11.6.3. Weigh 15 g of sample ± 1.0 g into a beaker or glass jar, recording the weight to the nearest 0.1 g on the benchsheet. Use 30 g of sodium sulfate for the method blank and LCS. Add 15 g of anhydrous sodium sulfate to the samples and mix well. The mixture should have a free flowing texture. If not, add

more sodium sulfate. Add the sample/sodium sulfate mixture to a soxhlet thimble, but do not pack the thimble tightly. The extraction thimble must drain freely for the duration of the extraction period. A glass wool plug above and below the sample in the soxhlet extractor is an acceptable alternative for the thimble.

11.6.3.1. Sample weights less than 15 g but over 5 g may be used if the appropriate reporting limits can be met.

11.6.3.2. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP, using sodium sulfate as the matrix. The weight of sodium sulfate used should be approximately the weight of soil used in each sample.

11.6.3.3. Add the surrogate spiking solution to each sample, method blank, laboratory control sample (LCS), and matrix spikes. Add the appropriate matrix spiking solution to each matrix spike/matrix spike duplicate (MS/MSD) and LCS. Record spiking volumes and standard numbers on the benchsheet. Return spiking solutions promptly to refrigerator.

Test	Surrogate Solution		Matrix Spike Solution	
	Volume	Name	Volume	Name
8270C	0.25 mL	8270 Surrogate	0.5 mL	8270 Spike
PAH-SIM	0.5 mL	PAH Surrogate	0.5 mL	PAH Spike Mix
PAH-SIM-ID	0.10 mL	PAH-IS	0.05 mL	PAH-ID N.S.

Note: Contents of each solution are described in the tables in Section 17.

11.6.4. Place approximately 300 mL of 1:1 methylene chloride:acetone into a 500 mL round bottom flask containing one or two clean boiling chips. Attach the flask to the extractor and extract the sample for 16-24 hours at 4-6 cycles per hour. Check the system for leaks at the ground glass joints after it has warmed up.

WARNING: Open the chiller supply valves about 15 minutes before turning on the heating element and ensure that all of the condensers are cold before you turn the heating element on. Check all of the condensers about 15 minutes after starting the heating process to ensure that they are still cold and functioning properly. If this cleaning cycle is to be left unattended (e.g. overnight) the first chemist to arrive the next morning is to check all condensers to ensure that they are still cold and functioning properly.

11.6.5. Allow the extract to cool after the extraction is complete, then disassemble by gently twisting the soxhlet from the flask. Dry the extract in the flask by filtering it through a sodium sulfate filled funnel.

11.6.6. Collect the dried extract in a KD or other glass container. Rinse the flask, which contained the solvent extract with 20-30 mL of methylene chloride and

add it to the funnel to complete the quantitative transfer.

11.6.7. If the extract is not concentrated immediately, refrigerate it to protect from light. Alternatively, the extract bottle may be wrapped with foil to protect from light for short periods of time (i.e., overnight). Refer to Section 11.8 for concentration.

11.7. Waste Dilution

11.7.1. This method is used for materials that are soluble in an organic solvent.

11.7.2. Remove surrogate and matrix spiking solutions (see Table 7) from refrigerator and allow to warm to room temperature

11.7.3. Transfer 10 mL of the solvent to be used for dilution into a Teflon capped vial. Mark the meniscus on the vial, then discard the solvent.

11.7.4. Tare the vial, then transfer approximately 1g of sample to the vial. Record the weight to the nearest 0.1 g.

11.7.5. Add the surrogate solution. For GC/MS analysis, the surrogate solution should be 10x more concentrated than the normal solution. If performing matrix spikes, add the spiking solution. The spike solution should also be 10x more concentrated that the normal solution.

11.7.6. Dilute to 10 mL with the appropriate solvent, usually methylene chloride.

11.7.7. Add the 8270 or PAH waste-surrogate to a test tube and dilute to 10 mL with solvent. This is the method blank.

11.7.8. Add the 8270 or PAH waste-spike solution and the 8270 or PAH waste-surrogate to a test tube and dilute to 10 mL with solvent. This is the LCS. Repeat to make an LCSD if necessary.

11.7.9. Add 2 ± 0.1 g sodium sulfate to the samples. Cap and shake for 2 minutes.

11.7.10. Add 4-5 g sodium sulfate to a small funnel. The funnel can be plugged with glass wool or phase separation filter paper may be used to hold the sodium sulfate. Rinse funnel, filter paper, glass wool, and sodium sulfate with methylene chloride **BEFORE** pouring sample.

11.7.11. Pour the sample through the funnel, collecting as much as possible in a clean vial. **Do NOT** rinse the funnel with additional solvent, and **Do NOT** concentrate the sample. The final volume is defined as 10 mL.

11.7.12. Label the samples, which are now ready for cleanup or analysis.

11.8. Concentration

According to the type of analysis and any cleanup procedures needed, different final volumes may be required. Below are the "normal" final volumes for tests covered by this SOP:

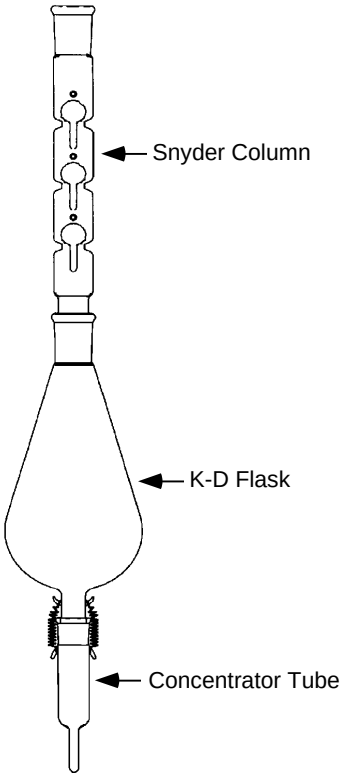
Test	Aqueous	Solid
8270C	1.0 mL	1.0 mL
1,4-Dioxane	1.0 mL	NA
PAH-SIM, PAH-SIM-ID	0.5 mL	0.5 mL

11.8.1. Kuderna-Danish (KD) Method:

11.8.1.1. Assemble a Kuderna-Danish concentrator as shown in Figure 2 by attaching a 10 mL concentrator tube to the 500 mL KD flask. Transfer the sample to the KD flask. Add one or two clean boiling chips and the extract to be concentrated to the KD flask and attach a three-ball Snyder column. Add approximately 1 mL of clean methylene chloride to the top of the Snyder column (this is important to ensure that the balls are not stuck and that the column will work properly).

11.8.1.2. Place the KD apparatus on a water bath (80-90ºC) so that the tip of the concentrator tube is submerged. (*For PAH-SIM, PAH-SIM-ID, and 1,4-Dioxane Analysis, concentrate at 70 – 75 ℃).* The water level should not reach the joint between the concentrator and the KD flask. At the proper rate of distillation, the balls will actively chatter but the chambers should not flood. Attach the solvent vapor recovery device to the top of the Snyder column.

Fgure 2, KD Setup (See Section 11.8. for description)



11.8.1.3. If performing an 8270 aqueous concentration, KD the base portion down first to approximately 50 mL. Remove the flask and filter in the remaining acid portion. Replace the flask to continue the concentration procedures.

11.8.1.4. Concentrate to 5-15 mL. The Snyder column may be insulated if necessary to maintain the proper rate of distillation.

Note: *It is very important not to concentrate to dryness as analytes will be lost.*

WARNING: Do not concentrate to dryness as an unsafe condition may be created.

11.8.1.5. Remove the KD apparatus from the water bath and allow to cool for a minimum of 10 minutes. If the level of the extract is above the level of the concentrator tube joint, add new boiling chips and continue to distill the solvent as necessary. Again, allow the KD flask to cool for a minimum of 10 minutes.

11.8.2. Nitrogen Evaporation to Final Concentration

*Note: If the extracts are proceeding to clean-up, skip to the next Section11.8.3 (*Nitrogen

Evaporation to Volume for Clean-up*).*

11.8.2.1. Quantitatively transfer the entire extract to an evaporation tube. Rinse the concentrator tube with 1-2mL of the appropriate solvent and transfer the solvent rinseate to the evaporation tube.

11.8.2.2. Evaporate the solvent using a gentle stream of nitrogen. The nitrogen flow will form a slight depression on the surface of the solvent, but should not create splattering of the extract.

11.8.2.3. During the course of the evaporation rinse the sides of the evaporation tube twice with approximately 1mL of clean solvent. The first rinse should be about half way through the process, with the second rinse when the solvent volume gets close to 1mL. Concentrate the solvent to below 1mL (below 0.5mL for PAH-SIM analysis) and quantitatively transfer the extract to the storage vial. Carefully adjust the volume in the vial to 1.0mL, using the standardized vial as a comparison.

11.8.2.4. The extract is now ready for instrumental analysis.

Note: *It is very important not to concentrate to dryness as analytes will be lost.*

Note: *The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.*

11.8.3. Nitrogen Evaporation to Volume for Clean-up

Note: If the extracts are not proceeding to clean-up, go to the previous Section (Nitrogen Evaporation to Final Concentration).

11.8.3.1. Transfer the entire extract to an evaporation tube. Rinse the concentrator tube with 1-2mL of the appropriate solvent and transfer the solvent rinsate to the evaporation tube.

11.8.3.2. Evaporate the solvent using a gentle stream of nitrogen. The nitrogen flow will form a slight depression on the surface of the solvent, but should not create splattering of the extract.

11.8.3.3. During the course of the evaporation rinse the sides of the evaporation tube twice with approximately 1mL of clean solvent. The first rinse should be about half way through the process, with the second rinse when the solvent volume gets close to 1mL. Concentrate the solvent to 1 – 1.2mL.

Note: *It is very important not to concentrate to dryness as analytes will be lost.*

Note: *As the entire sample will go through the clean-up column and be adjusted to an exact volume afterward, the extract volume at this step is not critical.*

11.8.3.4. Proceed to the appropriate Clean-up option in the following sections.

11.8.4. Nitrogen evaporation for final volume (Micoextraction)

11.8.4.1. Aliquot 5mL and transfer to 8mL screw cap test tube.

11.8.4.2. Evaporate the solvent using a gentle stream of nitrogen. The nitrogen flow will form a slight depression on the surface of the solvent, but should not create splattering of the extract.

11.8.4.3. During the course of the evaporation rinse the sides of the evaporation tube twice with approximately 1mL of clean solvent. The first rinse should be about half way through the process, with the second rinse when the solvent volume gets close to 1mL. Concentrate the solvent to 1.0mL.

Note: *It is very important not to concentrate to dryness as analytes will be lost.*

Note: *As the entire sample will go through the clean-up column and be adjusted to an exact volume afterward, the extract volume at this step is not critical.*

11.9. Clean-up of 8270 extracts

11.9.1. 8270 Extracts

11.9.1.1. *HLB column cleanup*. This pre-packed column may be used to trap co-extracted matrix contamination and yield cleaner 8270 extracts. This clean-up is recommended for 8270 extracts from soil and heavily contaminated water.

11.9.1.2. HLB lot verification procedure.
See Appendix 1

Note: Systems for eluting multiple cleanup cartridges include the Supelco, Inc. Solid Phase Extraction (SPE) assembly, Zymark Benchmate, or equivalent.

11.9.1.3. Attach a vacuum manifold to a vacuum pump or water aspirator with a trap installed between the manifold and the vacuum. Adjust the vacuum in the manifold to 5-10 psi.

11.9.1.4. Place a valve liner (Supelco, P/N# 57059, disposable flow control valve liner, or equivalent) into each port of the vacuum manifold.

WARNING: Use of vacuum systems creates a significant risk of implosion. Thoroughly inspect all glassware and do not use any that has been chipped, rubbed, cracked, or marred in any fashion.

WARNING: Ensure that the exhaust line from the vacuum pump is secured well inside of a fume hood so that it cannot fall out of the hood.

11.9.1.5. Place one HLB cartridge into the vacuum manifold for each sample extracts.

11.9.1.6. Prior to cleanup of samples, pre-elute each cartridge with 5 mL of DCM, then 5mL of MeOH.

11.9.1.7. During this step, adjust the vacuum applied to each cartridge so that the flow through each cartridge is approximately 2 mL/min.

11.9.1.8. Add 2mL of MeOH, drain through the column but stop the flow when the MeOH reaches the top of the cartridge. Do not let the cartridge go dry.

11.9.1.9. Place a rack of clean, labeled 16 mL test tubes into the manifold and replace the manifold top. Make sure that the solvent line from each cartridge is placed inside the appropriate tube.

11.9.1.10. After the clean tubes are in place, vacuum to the manifold is restored, add the extract to the appropriate cartridge. This is the entire sample.

11.9.1.11. The extract concentrates are then eluted through the column with 10 mL of acetone and are collected into the 16 mL test tube or held in the rack inside the vacuum manifold.

11.9.1.12. Use nitrogen evaporation (Section 11.8.2) to concentrate the extract to approximately 1 mL. Add 5mL DCM and re-concentrate to 1.0mL (for a thorough removal of acetone).

11.9.1.13. Once returned to 1.0mL, the sample is ready for instrumental analysis.

Note: It is very important not to concentrate to dryness as analytes will be lost.

Note: *The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.*

11.10. Clean-up of 8270SIM-PAH Extracts

11.10.1. Use clean 20mm glass columns packed with a plug of DCM rinsed glass wool.

11.10.2. Rinse the glass wool and column with Hexane

11.10.3. Add 4cm of activated silica gel (~10g) then a 2cm layer of sodium sulfate.

Tap the column while adding these reagents to prevent channeling. Elute and discard 40 mL Hexane.

11.10.4. Add the sample extract to the top of the column by quantitative transfer with 2 rinses. (The sample volume can be between 1 and 5 mL).

11.10.5. Immediately after adding the sample, elute the column with 25 mL of hexane.

11.10.6. Just before the last of the hexane hits the sodium sulfate layer, add 25 mL of hexane:methylene chloride (2:3)

11.10.7. Collect the entire elute mix in a 250mL flask.

11.10.8. Following the Kuderna Danish Concentration section in this SOP, concentrate the extract to low volume (approximately 5mL) and complete the solvent re-exchange by adding 50mL of DCM and concentration to approx 5mL.

11.10.9. Proceed to the Nitrogen Evaporation to Final Concentration section.

12. CALCULATIONS/DATA REDUCTION

12.1. Not applicable.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP WS-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Extracted aqueous/TCLP leachate samples contaminated with methylene chloride are collected at the fume hood in a 5-gallon or smaller carboy. If the samples are not at a neutral pH, add small quantities of sodium bicarbonate to bring the waste to neutral. Stir well. Once neutralized, immediately pour the carboy contents into a blue plastic LLE drum in the H3 closet. When full to between one and four inches of the top, or after no more than 75 days, move the LLE drum to the waste collection area for shipment.

15.2. Extracted soil samples and thimbles, sodium sulfate, glass wool/filter paper contaminated with methylene chloride and acetone from sonication and soxhlet extraction. Pour any excess liquid from the extracted soil samples as outlined below (Section 15.4). Dump the extracted soil and thimbles into an orange contaminated lab trash bucket. When the bucket is full or at the end of the day, tie the plastic bag liner shut and put the lab trash into the appropriate collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.3. Used assorted disposable glassware and materials contaminated with methylene chloride. Dump the solid waste into a yellow contaminated lab trash bucket. When the bucket is full or at the end of the day, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.4. Mixed flammable solvent and methylene chloride waste generated during soil extraction, glassware and sodium sulfate cleaning.. Collect the waste solvents in tripours during use. Empty the tripours into a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the steel solvent drum in the H3 closet. When full to between two and six inches of the top, or after no more than 75 days, move the steel drum to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III

Method 3500B, Organic Extraction and Sample Preparation, Revision 2, December 1996

Method 3510C, Separatory Funnel Liquid Liquid Extraction, Revision 3, December 1996

Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996

Method 3540C, Soxhlet Extraction, Revision 3, December 1996

Method 3550B, Ultrasonic Extraction, Revision 2, December 1996

Method 3580A, Waste Dilution, Revision 1, July 1992

Method 3600C, Cleanup, Revision 3, December 1996

Method 3511, Organic Compounds in Water by Microextraction, Revision 0, November 2002

17. METHOD MODIFICATIONS

17.1. Some surrogate spiking concentrations are modified from those recommended in SW-846, in order to make the concentrations more consistent with the calibration levels in the determinative methods.

17.2. Aqueous sample volumes may be determined by weight.

18. ATTACHMENTS

18.1. Table 1- Components of 8270 Matrix Spike

18.2. Table 2 - Components of 8270 Surrogate Spike

18.3. Table 3 - Components of 1,4-Dioxane Matrix Spike Solution

18.4. Table 4 – Components of PAH –SIM Internal Standard (Surrogate) Solution

18.5. Table 5 – Components of PAH-SIM Matrix Spike Solution

18.6. Table 6 – Components of PAH-SIM-1D Matrix Spike Solution

18.7. Table 7 – TestAmerica West Sacramento 8270C Extraction Summary

18.8. Appendix 1 – Cleanup Cartridge Lot Verification.

19. REVISION HISTORY

19.1. WS-OP-0001, Revision 3.6, Effective 04/20/2012

19.1.1. Inserted Section 11.4 – Microextraction for water

19.1.2. Editorial changes

19.2. WS-OP-0001, Revision 3.5, Effective 7/25/2011

19.2.1. Inserted Section 7.2.1: Oasis HLB Extraction Cartridge: 500 mg pre-packed in 6mL cartridges with polyethylene frits (Waters part # 186000115, or equivalent).

19.2.2. Inserted Section 7.2.2: Activated Silica Gel: Activate for at least 1 hour at 190degC (+/- 5deg). Store at 130-200 deg C in a covered glass container.

19.2.3. Inserted Section 11.7.3, Nitrogen Evaporation to Volume for Clean-up.

19.2.4. Inserted Section 11.8, Clean-up of 8270 extracts

19.2.5. Inserted Section 11.9, Clean-up of 8270SIM-PAH Extracts

19.2.6. Updated Table 7.

19.2.7. Inserted Appendix 1.

19.2.8. Editorial revisions.

19.3. WS-OP-0001, Revision 3.4, Effective 10/22/2010

19.3.1. Changed PAH SIM-ID volume in Matrix Spike Solution Tables 11.2.4, 11.3.4, 11.4.6k, and 11.5.3.3.6 from 0.5 mL to 0.05 mL and name from PAH-ID Spike Mix to PAH-ID N.S.

19.3.2. Updated Tables 4 analyte concentrations from 1.0 to 20 ug/mL, Talbe 6 analyte concentrations from 2.0 ug/mL to 20 ug/mL, and Table 7 Surrogate column for PAH-ID (FX) from 0.25 mL to 100 uL and LCS column from 0.5 mL to 50 uL.

19.3.3. Added Sections 11.2.1.1 and 11.3.1.1: If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.
b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.
c) Processing the aqueous portion as described in a) along with creating a new sample ID for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to create a second extract for the sample that is to be added to the extraction batch of water samples

19.4. WS-OP-0001, Revision 3.3, Effective 12/15/2009

19.4.1. Added Section 11.4.8, "Make sure that all sonicator horns have been cleaned prior to sonicating. To achieve a clean sonicator horn, immerse each sonicator horn in a tri-pour beaker of de-ionized (DI) water for 2-3 pulses. Immediately rinse the horns with acetone to remove any excess water. Finish by rinsing each horn with dichloromethane (DCM). Sonicators are ready for use.

19.5. WS-OP-0001, Revision 3.2, Effective 11/10/2009

19.5.1. Added to the end of Section 7.2: "Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks, in accordance with SOP WS-QA-0014, 'Monitoring of Reagent-Grade Laboratory Water.'"

19.6. WS-OP-0001, Revision 3.1, Effective 9/04/2009

19.6.1. Added Section 1.3, "When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 'DoD QSM and AFCEE QAPP Implementation' must be checked and incorporated."

19.6.2. Inserted Section 10.1, "For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 'Calibration Curves (General)'."

Table 1 Components of 8270 Matrix Spike			
Analyte Name	**Concentration µg/mL**	**Analyte Name**	**Concentration µg/mL**
1-Methylnaphthalene	100	Acenaphthene	100
Acenaphthylene	100	Aniline	100
Anthracene	100	Azobenzene	100
Benzo(a)anthracene	100	Benzo(a)pyrene	100
Benzo(b)fluoranthene	100	Benzo(g,h,i)perylene	100
Benzo(k)fluroanthene	100	Benzoic acid	100
Benzyl alcohol	100	Bis(2-chloroethoxy) methane	100
Bis(2-chloroethyl) ether	100	Bis(2-chloroisopropyl) ether	100
Bis(2-ethylhexyl) phthalate	100	Bis-2-ethylhexyl adipate	100
Butyl benzyl phthalate	100	Carbazole	100
Chrysene	100	Di-n-butyl phthalate	100
Di-n-octyl phthalate	100	Dibenz (a,h) anthracene	100
Dibenzofuran	100	Diethyl phthalate	100
Dimethyl phthalate	100	Fluoranthene	100
Fluorene	100	Hexachlorobenzene	100
Hexachlorobutadiene	100	Hexachlorocyclopentadiene	100
Hexachloroethane	100	Indeno(1,2,3-c,d)pyrene	100
Isophorone	100	n-Nitroso-di-n-propylamine	100
n-Nitroso-dimethylamine	100	n-Nitroso-diphenylamine	100
Naphthalene	100	Nitrobenzene	100
Pentachlorophenol	100	Phenanthrene	100
Phenol	100	Pyrene	100
Pyridine	100	1,2-Dichlorobenzene	100
1,2-Dinitrobenzene	100	1,2,4-Trichlorobenzene	100
1,3-Dichlorobenzene	100	1,3-Dinitrobenzene	100
1,4-Dichlorobenzene	100	1,4-Dinitrobenzene	100
2-Dhloronaphthalene	100	2-Chlorophenol	100
3-Methyl-4,6-dinitrophenol	100	2-Methylnaphthalene	100
2-Methylphenol	100	2-Nitroaniline	100
2-Nitrophenol	100	2,3,4,6-Tetrachlorophenol	100
2,3,5,6-Tetrachlorophenol	100	2,4-Dichlorophenol	100
2,4-Dimethylphenol	100	2,4-Dinitrophenol	100
2,4-Dinitrotoluene	100	2,4,5-Trichlorophenol	100
2,4,6-Trichlorophenol	100	2,6-Dinitrotoluene	100
3-Methylphenol	100	3-Nitroaniline	100
3,3-Dichlorobenzidine	100	4-Bromophenylphenyl ether	100
4-Chloro-3-methylphenol	100	4-Chloroaniline	100
4-Chlorophenylphenyl ether	100	4-Methylphenol	100
4-Nitroaniline	100	4-Nitrophenol	100

Table 2	
Components of 8270C Surrogate Spike	
Analyte Name	**Concentration µg/mL**
Nitrobenzene-d5	100
p-Terphenyl-d14	100
Phenol-d6	150
1,2-Dichlorobenzene-d4	100
2-Chlorophenol-d4	150
2-Fluorobiphenyl	100
2-Fluorophenol	150
2,4,6-Tribromophenol	150

Table 3 Components of 1,4-Dioxane Matrix Spike Solution	
Analyte Name	**Concentration (µg /mL)**
1,4-Dioxane	200

Table 4 Components of PAH-SIM Internal Standard (Surrogate) Solution (Used only for PAH-SIM-ID)			
Analyte Name	**Concentration (µg /mL)**	**Analyte Name**	**Concentration (µg /mL)**
Naphthalene-d8	20.0	Acenaphthylene-d8	20.0
Acenaphthene-d10	20.0	Fluorene-d10	20.0
Phenanthrene-d10	20.0	Fluoranthene-d10	20.0
Pyrene-d10	20.0	Benzo(a)anthracene-d12	20.0
Chrysene-d12	20.0	Benzo(b)fluroanthene-d12	20.0
Benzo(k)fluoranthene-d12	20.0	Benzo(a)pyrene-d12	20.0
Perylene-d12	20.0	Indeno(1,2,3-cd)pyrene	20.0
Dibenzo(a,h)anthracene-d14	20.0	Benzo(g,h,i)perylene-d12	20.0

Table 5
Components of PAH-SIM Matrix Spike Solution

Analyte Name	Concentration (µg/mL)	Analyte Name	Concentration (µg/mL)
Naphthalene	0.5	2-Methylnaphthalene	0.5
1-Methylnaphthalene	0.5	Acenaphthylene	0.5
Acenaphthene	0.5	Anthracene	0.5
Fluorene	0.5	Phenanthrene	0.5
Fluoranthene	0.5	Pyrene	0.5
Benzo(a)anthracene	0.5	Chrysene	0.5
Benzo(b)fluoranthene	0.5	Benzo(k)fluoranthene	0.5
Benzo(a)pyrene	0.5	Indeno(1,2,3-cd)pyrene	0.5
Dibenzo(a,h)anthracene	0.5	Benzo(ghi)perylene	0.5

Table 6
Components of PAH-SIM-ID Matrix Spike Solution
(Used for PAH-SIM)

Analyte Name	Concentration (µg/mL)	Analyte Name	Concentration (µg/mL)
Naphthalene	20.0	2-Methylnaphthalene	20.0
1-Methylnaphthalene	20.0	Acenaphthylene	20.0
Acenaphthene	20.0	Anthracene	20.0
Fluorene	20.0	Phenanthrene	20.0
Fluoranthene	20.0	Pyrene	20.0
Benzo(a)anthracene	20.0	Chrysene	20.0
Benzo(b)fluoranthene	20.0	Benzo(k)fluoranthene	20.0
Benzo(a)pyrene	20.0	Indeno(1,2,3-cd)pyrene	20.0
Dibenzo(a,h)anthracene	20.0	Benzo(ghi)perylene	20.0

TABLE 7
TestAmerica West Sacramento 8270C Extraction Summary

Method (Method Code)	Sample Amount	Surrogate	LCS	pH 1 / pH 2	Extract Solvent/Vol.	Extraction Time	Comments
8270C (QL) (Aq, SEPF)	1L	0.5mL 8270 Surrogate (100/150 ug/mL)	1.0 mL 8270 Spike (100 ug/ml)	1-2 / 11-12	3 x 60mL DCM 3 x 60mL DCM	2min shake, 10min rest	Leachates use 200mL diluted to 1L with rgt water. FV=1.0mL
8270C (QL) (Aq, CLLE)	1L			1-2 / 11-12	300 – 500 mL	18-24 hrs	
8270C (QL) (Solid, SONC)	30g			NA	3 x 100mL DCM:Acetone 1:1	3 min	FV=1.0mL
8270C (QL) (Solid, Soxhlet)	15g	0.25mL 8270 Surrogate (100/150 ug/mL)	0.5 mL 8270 Spike (100 ug/ml)	NA	300 mL	16 - 24 hrs	FV = 0.5 mL
8270C (QL) (Waste Dil'n)	1 g	0.5mL 8270 Waste-Surrogate (1000ug/mL)	1 mL 8270 Waste-Spike (200ug/mL)	NA	10mL	NA	Don't concentrate
1,4-Dioxane (FX) (Aq, SEPF)	1L	50 µL 8270 Surrogate	50 µL 1,4-Dioxane 200µg/mL	NA	3 x 60mL DCM	2min shake, 10min rest	FV=1.0mL
PAH (QI) (Waste Dil'n)	1 g	0.5 mL PAH Waste Surrogate, (10ug/mL)	0.5 mL PAH Waste Spike, (10ug/mL)	NA	10mL	NA	Don't concentrate
PAH (QI) (Aq, SEPF)	1L	0.5mL 8270 Surrogate	0.5 mL PAH Spike Mix (0.5 ug/mL)	NA	3 x 60mL DCM	2min shake, 10min rest	FV=0.5mL
PAH (QI) (Aq, CLLE)	1L			NA	300 – 500 mL	18-24 hours	
PAH (QI) (Solid, SONC)	10 g			NA	3 x 100mL DCM	3 min	
PAH (QI) (Solid, SOX)	10g			NA	300 mL	16 - 24 hours	
PAH-ID (FX) (Aq, SEPF)	1L	100 µL of PAH –ID I.S.. (20 µg/µl)	50 µL of PAH –ID N.S. (20 µg/µl)	NA	3 x 60mL DCM	2min shake, 10min rest	FV=0.5mL
PAH-ID (FX) (Aq, CLLE)	1L			NA	300 – 500 mL	18-24 hrs	
PAH-ID (FX) (Solid, SONC)	10 g			NA	3 x 100mL DCM	3 min	
PAH-ID (FX) (Solid, SOX)	10g			NA	300 mL	16 - 24 hrs	

SEPF = Separatory Funnel; SONC = Sonication; SOX = Soxhlet; CLLE = Continuous Liquid-Liquid Extraction

Extracts prior to KD should be stored refrigerated.

Pour the dried extract into the KD.

KD to about 1 mL

Transfer to evaporation tube, take to less than final volume (< 1mL for 8270 and 1,4-dioxane, < 0.5 mL for PAH or Soxhlet samples.)

Quantitatively transfer to vial, adjust to final volume.

Put in box, complete paperwork, and transfer to instruments.

Appendix 1

Clean-up Cartridge lot verification

HLB lot verification procedure.

Each lot of HLB cartridges must be evaluated before use, following this performance check procedure:

Obtain 1.0mL of a 50ug/mL mid-level solution of 8270 compounds in DCM (prepared from the GCMS calibration stock). This can be obtained from the GCMS group.

In a clean test tube add:

1.0mL of this HLB check solution (8270 standard).

Add this to a pre-washed HLB cartridge. Process this per the instructions in the Clean-up of 8270 Extracts section. For a blank sample, repeat this step on another cartridge loaded with 2mL of clean DCM. Deliver 1.0mL of the final cleaned HLB check and blank to the GCMS instrument group for analysis.

Analyze the HLB check solution and blank, per method 8270. Expected recoveries are 70-120% of all analytes and surrogates with the exception of the ones listed below, which cannot typically meet this criterion. At a minimum, the recoveries will meet the current LCS limits for soils. Additionally, there should be no indication of peaks interfering with target compounds.

Compounds with Low Recoveries Expected in HLB Checks

- Pyridine
- Aniline
- Benzoic Acid
- 4-Chloraniline
- 2,4-Dinitrophenol
- 4,6-Dinitro-2-methylphenol
- 3, 3'-Dichlorobenzidine

Title: Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 3500 Series and 3600 Series Methods for Analysis by Methods 8015B, CA-LUFT, NW-TPH, and AK 102/103 [Methods 8015B and AK 102/103]

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1. SCOPE AND APPLICATION

This SOP describes procedures for preparation (extraction and cleanup) of semivolatile organic analytes in aqueous, solid and waste matrices for analysis by Gas Chromatography (GC). The procedures are based on SW-846 methodology and are applicable for measurements made to comply with the Resource Conservation and Recovery Act (RCRA).

1.1. Extraction procedures for the TPH-Diesel determinative methods are covered.

1.2. Other extraction procedures (PFE, SPE, accelerated Soxhlet, etc.) may be used but are not currently covered in this SOP.

1.3. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPPP Implementation" must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. Separatory Funnel Extraction

A measured volume of sample, typically 1 liter, is adjusted, if necessary, to a specified pH and serially extracted with methylene chloride using a separatory funnel.

2.2. Continuous Liquid/Liquid Extraction (CLLE)

A measured volume of sample, typically 1 liter, is placed into a continuous liquid/liquid extractor, adjusted, if necessary, to a specific pH and extracted with methylene chloride for 18-24 hours.

2.3. Sonication Extraction

A measured weight of sample, typically 30 g, is mixed with anhydrous sodium sulfate to form a free flowing powder. This is solvent-extracted with methylene chloride three times using an ultrasonic horn.

WARNING: Hearing protection is required when sonicating samples.

2.4. Soxhlet Extraction

A 30 g sample is mixed with anhydrous sodium sulfate to form a free flowing powder. This is extracted with refluxing methylene chloride for 16-24 hours.

2.5. Waste Dilution

A 1 g sample aliquot is diluted to 10 mL with methylene chloride.

2.6. Cleanup and Concentration

Procedures are presented for removing interferents from sample extracts, and for drying and concentration of the extract to final volume for analysis.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.2. Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Nitrile gloves should be used when performing this extraction. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP, and should not be used.

5.1.2. Exposure to chemicals must be maintained as low as reasonably achievable; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.3. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other

ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.1.4. Sulfuric acid cleanup must not be performed on any matrix that may have water present as a violent reaction between the acid and water may result in acid exploding out of the vessel.

5.1.5. Assembly and disassembly of glassware creates a risk of breakage and cuts. All staff members shall wear Kevlar® or similar cut-resistant gloves over chemically resistant gloves when assembling and disassembling glassware.

5.1.6. All glassware must be inspected before use. Chipped, cracked or broken glassware must be removed from service immediately, especially glass separatory funnels. This glassware must either be sent out for repair or discarded.

5.1.7. During Kuderna-Danish (KD) concentration, do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard.

5.1.8. The use of separatory funnels to extract aqueous samples with methylene chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the sample container has been sealed and inverted. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity, and a face shield must be worn over safety glasses or goggles when it is performed.

5.1.9. The kiln used to clean glassware creates an extreme risk of severe burns. Allow sufficient time for the kiln to cool before opening the doors. Ensure that appropriate heat protective gloves are worn when working with freshly kilned glassware. Other surfaces in the kiln may remain hot; so exercise caution when reaching into the kiln.

5.1.10. All personnel are to ensure liquid-liquid area is clear of unnecessary items. Heating mantles used with liquid-liquid extractions generate temperatures that could ignite some materials that come in contact with the heating mantles.

5.1.11. Ensure that all solvents are kept away from liquid-liquid extractors. Increased temperatures near solvents can cause the pressure in the containers to increase.

5.1.12. Ensure that all boiling flasks have cooled to room temperature before disconnecting liquid-liquid bodies from boiling flasks to prevent any burns.

5.1.13. Ultrasonic disrupters produce high intensity noise and must be used in an area with adequate noise protection. Hearing protection must be worn when operating sonicators.

5.2. Primary Material Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sodium Hydroxide	Corrosive	2 mg/m^3-Ceiling	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain, and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Glassware should be cleaned with soap and water, rinsed with water and kilned in an oven at 400°C for at least 2 hours. Refer to SOP WS-OP-0011 for details of glassware cleaning. Kilned glassware does not require solvent rinsing before use.

WARNING: Heat resistant gloves must be used when handling kilned glassware.

6.2. Equipment and supplies for extraction procedures.

6.2.1. Separatory funnel, 2L

6.2.2. Separatory funnel rotator

6.2.3. Balance: >1400 g capacity, accurate ±1 g

6.2.4. pH indicator paper, wide-range: covers extraction pH

6.2.5. Graduated cylinder: 1 liter. (Other sizes may be used)

6.2.6. Erlenmeyer flask, beaker, or French square jar: 125 & 300 mL (other sizes optional)

6.2.7. Solvent dispenser pump or 100 mL graduated cylinder

6.2.8. Continuous liquid/liquid extractor

6.2.9. Round or flat bottom flask: 250, 500 mL or 1 L

6.2.10. Boiling chips: contaminant free, approximately 10/40 mesh (Teflon® PTFE, carbide or equivalent).

6.2.11. Cooling condensers

6.2.12. Heating mantle: Rheostat controlled, with timer

6.2.13. Beakers: 250 & 400 mL, graduated

6.2.14. Balance: >100 g capacity, accurate to ± 1g

6.2.15. Soxhlet extractor

6.2.16. Sonicator (at least 300 watts), with sonicator horn, 3/4 inch

6.2.17. Kuderna-Danish (KD) apparatus: 500 mL flask, with 10mL concentrator tube, and 3-ball macro Snyder column

6.2.18. Locally assembled solvent vapor condensing/recovery system for use with 6.2.17 above.

6.2.19. Water bath: heated, with concentric ring cover, capable of temperature control (± 5°C) up to 95°C. The bath must be used in a hood or with a solvent recovery system.

6.2.20. Nitrogen blowdown apparatus,

6.2.21. Culture tubes: 10 mL, 16 mm x100 mm

6.2.22. Syringe: 1 mL

6.2.23. Glass wool

6.2.24. Glass funnel: 75 X 75 mm

6.2.25. Disposable pipets

6.2.26. Aluminum foil

6.2.27. Paper towels

6.3. Equipment and Supplies for Cleanup Procedures

6.3.1. Mechanical shaker or mixer: Vortex Genie or equivalent.

6.3.2. Disposable pipets

6.3.3. Culture tubes: 10 mL, 16 mm x100 mm

7. REAGENTS AND STANDARDS

7.1. All reagents must be ACS reagent grade or better unless otherwise specified.

7.1.1. Sodium hydroxide solution, 10 N

7.1.2. Sulfuric acid (H_2SO_4), concentrated: reagent grade

7.1.3. Sulfuric acid (1:1): carefully add 500 mL of H_2SO_4 to 500 mL of reagent water. Mix well.

WARNING: Always add concentrated acids or bases to water, never add water to the concentrated acid or base.

7.1.4. Organic free reagent water.

7.1.5. Sodium sulfate (Na_2SO_4), granular, anhydrous: Purify by heating at 400°C a minimum of two hours.

7.1.6. Extraction/exchange solvents: methylene chloride, acetone.

7.1.7. Acetone: used for cleaning.

7.1.8. Nitrogen, reagent grade.

7.1.9. Silica gel.

7.2. Standards

7.2.1. Stock Standards

Stock standards are purchased as certified solutions or prepared from neats. Semivolatile stock standards are stored at ≤ 6°C. All stock standards must be protected from light.

7.2.1.1. Stock standard solutions must be replaced after one year (from the time of preparation, if prepared in house, or from the time the ampule is opened if purchased), or the manufacturer's expiration date, whichever is sooner. Standards must be allowed to come to room temperature before use.

7.2.1.2. Expired standards must be rotated out of the lab to the Hazardous Waste storage area.

7.2.2. Surrogate Spiking Standards

Prepare or purchase surrogate spiking standards at the concentrations listed in Table 1. Surrogate spiking standards are prepared as dilutions of stock standards. Surrogate spiking solutions must be refrigerated and protected from light. The standards are given a 6 month expiration date from the time of preparation, or the expiration date of the stock solution, whichever is sooner. Standards may be replaced sooner if there is reason to believe that the standard has degraded or concentrated.

7.2.3. Matrix Spiking and Laboratory Control Spiking Standards

The same spiking solution is used for the matrix spike (MS) and the laboratory control sample (LCS). Prepare MS/LCS spiking standards at the concentrations listed in Table 2. Spiking standards are purchased or prepared as dilutions of stock standards. Spiking solutions must be refrigerated and protected from light. The standards are given a 6 month expiration date from the time of preparation, or the expiration date of the stock solution, whichever is sooner. Standards may be replaced sooner if there is reason to believe that the standard has degraded or concentrated.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Samples are not chemically preserved (exception: Samples for Alaska methods AK102 & AK103. See Section 8.3.1).

8.2. Samples are stored at ≤ 6°C in glass containers with Teflon®-lined caps.

8.3. Holding Times

8.3.1. Extraction is initiated within 7 days of the sampling date for aqueous samples, 14 days for solid and waste samples. Aqueous samples for California LUFT may be extracted within 14 days with client approval. Holding time for aqueous samples for Alaska methods AK102 & AK103 is 14 days when preserved to pH < 2.

8.3.2. For TCLP leachates, extraction is initiated within seven days from when the leaching procedure is completed.

8.3.3. Analysis of the extracts must be completed within forty days of extraction.

9. QUALITY CONTROL

9.1. Quality Control Batch

The batch is a set of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The batch must contain a method blank, an LCS and a matrix spike/matrix spike duplicate. (In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD). If clients request specific samples for MS/MSD, the batch may contain multiple MS/MSD. See policy WS-PQA-003 for further definition of the batch.

9.2. Method Blank

A method blank consisting of all reagents added to the samples must be prepared and analyzed with each batch of samples. Surrogates are spiked into the method blank at the same level as the samples. The method blank is used to identify any background interference or contamination of the analytical system, which may lead to the reporting of elevated concentration levels or false positive data.

9.2.1. Aqueous method blanks use 1000 mL of reagent water spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.2.2. Solid method blanks use 30 g of sodium sulfate spiked with the surrogates. The method blank goes through the entire analytical procedure, including

any cleanup steps.

9.2.3. TCLP method blanks use 200 mL of leachate fluid spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.2.4. Method blanks for waste dilution procedures consist of the solvent used to dilute the sample, spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.3. Laboratory Control Sample (LCS)

Laboratory control samples are well-characterized, laboratory generated samples used to monitor the laboratory's day to day performance of routine analytical methods. The LCS, spiked with a group of target compounds representative of the method analytes, is used to monitor the accuracy of the analytical process, independent of matrix effects. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision. The LCS goes through the entire analytical procedure, including any cleanup steps.

9.3.1. The LCS is made up in the same way as the method blank (See Sections 9.2.1 - 9.2.4) but is spiked with the LCS standard and the surrogates.

9.4. Surrogates

9.4.1. Surrogates are organic compounds which are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.

9.4.2. Each applicable sample, blank, LCS and MS/MSD is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining whether the concentration (measured as percent recovery) falls within the required recovery limits.

9.5. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike is an environmental sample to which known concentrations of target analytes have been added. A matrix spike duplicate is a second spiked aliquot of the same sample, which is prepared and analyzed along with the sample and matrix spike.

9.6. Laboratory Control Sample Duplicate (LCSD)

A laboratory control sample duplicate (LCSD) may be substituted for a MS/MSD if there is insufficient sample available to process a MS/MSD, if precision data is required by the client or program. Certain programs, such as Alaska or Arizona, require an LCSD in addition to LCS/MS/MSD. In the cases where an LCSD is

processed, the LCS pair is then evaluated according to the MS/MSD RPD criteria. Use of a LCS pair in place of a MS/MSD must be documented on an NCM.

9.7. Initial Demonstration of Capability

The initial demonstration and method detection limit studies described in Section 13 must be acceptable before analysis of samples may begin.

9.8. Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries (QAS) should be developed to address these requirements.

9.9. West Sacramento QC Program

Further details of QC and corrective action guidelines are presented in the West Sacramento QC Program document (WS-PQA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION

10.1. On the day of use, measure 3.0 mL (or other appropriate volume, as per Section 11.9) of methylene chloride into a 16 mL culture tube using a graduated pipet. The "standard" culture tube is sealed. The culture tubes containing the sample extracts are then compared against the "standard" culture tube to ensure that the final volume is consistently 3.0mL (or as specified in Section 11.9) ± 0.1 mL. If a new box of culture tubes is used, then the steps are repeated to further ensure that variations due to tube size and shape are minimized.

10.2. On a monthly basis, calibrate any auto-pipettors to be used in accordance with SOP WS-QA-0004.

10.3. On the day of use, calibrate any balances to be used in accordance with SOP WS-QA-0041.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Method 3510C, Separatory Funnel Liquid/Liquid Extraction of Water Samples

11.2.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.2.2. Measure the initial sample pH with wide-range pH paper by dipping a disposable pipette into the sample and wetting the pH paper. Record on the extraction benchsheet. If the sample is a leachate, e.g. TCLP, compare the current pH against the leachate log and note on the benchsheet if there is any discrepancy.

11.2.3. The normal sample volume is 1 liter. Other sample volumes may be used to obtain specific reporting limits, and reduced sample volumes, diluted to 1 liter with reagent water, may be used for very dirty samples.

11.2.3.1. If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.

b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.

c) Processing the aqueous portion as described in a) along with creating a new sample id for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to create a second extract for the sample that is to be added to the extraction batch of water samples

NOTE: In the case of option "b", after adding the appropriate surrogates/spikes, the sample would be gently swirled for mixing purposes and then gently poured into the separatory funnel, thus minimizing the amount of sediment transferred to the extraction vessel during the process. The original sample container would then be rinsed with 60 mL of DCM. This DCM rinseate would then be poured into the extraction vessel.

11.2.4. Weigh the sample container on a balance (± 1 g), taring the sample and container. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples.

Test	Surrogate Solution		LCS/MS Solution	
	Volume	Name	Volume	Name
Normal	100 µL	OTP/Triacontane	100 µL	Diesel
AFCEE	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	TBD*	Jet Fuel*
NWTPH-Dx	150 µL	OTP/Triacontane	150 µL	Diesel
Si Gel Cleaned	100 µL	OTP/Triacontane	100 µL	Diesel
Hi-Level	500 µL	OTP/Triacontane	500 µL	Diesel
AK102/103	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	100 µL	Motor Oil

Note: Contents of each solution are described in the tables at the end of this SOP.

**If Jet Fuel (JPA, JP4, or JP8) is an analyte of concern, AFCEE requires that it be spiked. Consult with your department manager about concentration/volumes to be used.*

11.2.5. Mix well, or if the sample contains sediment, decant before transfer. Transfer the sample to the separatory funnel. Rinse the sample bottle with 60 mL methylene chloride and transfer to the separatory funnel. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

WARNING: Methylene chloride creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the sample container has been sealed and inverted. Vent into hood away from analysts and other samples.

Note: If the sample bottle is completely full, it may be difficult to add the spike solutions to the bottle. In this case, transfer part of the sample to the separatory funnel and then add the spike to the bottle.

11.2.5.1. If the entire sample bottle will not be used, measure an aliquot using a graduated cylinder, transfer the aliquot to the separatory funnel, then add the spiking solutions to the sample in the separatory funnel.

Note: Alternative methods of measurement of sample volume include a) transferring the sample to a measuring cylinder and b) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.

11.2.6. For TCLP samples, use 200 mL of leachate measured in a graduated

cylinder. Dilute the leachate to approximately 1 L with reagent water. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples. Add 60 mL of methylene chloride to the separatory funnel.

11.2.7. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP. Use 1 L of reagent water for method blanks and LCS. The LCS is spiked with the surrogate and matrix spike solutions, the method blank only with the surrogate(s). See Section 11.2.4 for details of spiking.

11.2.8. For a TCLP batch, prepare a reagent blank and LCS as in the section above. In addition, prepare a TCLP method blank and LCS duplicate by measuring 200 mL of the buffer solution used in the leaching procedure and transferring to the separatory funnel. Dilute the leachate to approximately 1 L with reagent water. The LCS is spiked with the surrogate and matrix spike solutions, the method blank and reagent blank only with the surrogates. Add 60 mL of methylene chloride to the separatory funnel.

11.2.9. Record spiking volumes, standard IDs, and reagent lots on the benchsheet. Return spiking solutions to the refrigerator as soon as possible.

11.2.10. Seal and shake or rotate the separatory funnel vigorously for 2 minutes with periodic venting to release excess pressure.

WARNING: Methylene chloride creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the separatory funnel has been sealed and inverted. Vent into hood away from analysts and other samples.

11.2.11. Allow the organic layer to separate from the water phase until complete visible separation has been achieved (at least 10 minutes). If the emulsion interface between layers is more than one-third the size of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods. If the emulsion cannot be broken (recovery of <80% of the methylene chloride*), transfer the sample, solvent, and emulsion into the extraction chamber of a continuous extractor and proceed as described in continuous liquid-liquid extraction (Section 11.3.). If this is done, the sample must be extracted as part of a valid CLLE batch.

11.2.12. *Note: 15 - 20 mL of methylene chloride is expected to dissolve in 1 L of water. Thus, solvent recovery could be as low as 40 mL from the first shake and still be acceptable. Subsequent shakes should recover at least 50 mL of solvent.

11.2.13. Fill a funnel with 10-20 g of anhydrous sodium sulfate. The funnel can be plugged with glass wool to hold the sodium sulfate. Drain the solvent extract from the separatory funnel through the prepared filtration funnel into a clean glass container. The extract may be drained directly into the KD flask. Close the stopcock just before the water level begins draining out of the separatory funnel. If the sodium sulfate becomes saturated with water add more to the funnel or replace the existing sodium sulfate with fresh drying agent.

Note: Alternatively, the three extracts may be collected together and then filtered through the sodium sulfate prior to the concentration step.

11.2.14. Repeat the extraction process two more times using fresh 60 mL portions of solvent, combining the three solvent extracts in the collection container.

11.2.15. Rinse the extract residue from the sodium sulfate by pouring 20-30 mL of clean methylene chloride through the funnel and into the collection container.

11.2.16. Dispose of solvent and water remaining in the extractor into the LLE (liquid/liquid extraction) waste drum. Waste methylene chloride goes to the DCM drum for recycling.

11.2.17. Cap the collection container if the extract is not concentrated immediately. Refer to Section 11.7 for concentration and Section 11.10 for cleanup.

11.3. Method 3520C, Continuous Liquid/Liquid Extraction from Water Samples

11.3.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.3.1.1. If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.
b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.
c) Processing the aqueous portion as described in a) along with creating a new sample id for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to

create a second extract for the sample that is to be added to the extraction batch of water samples

NOTE: In the case of option "b", after adding the appropriate surrogates/spikes, the sample would be gently swirled for mixing purposes and then gently poured into the separatory funnel, thus minimizing the amount of sediment transferred to the extraction v vessel during the process. The original sample container would then be rinsed with 60 mL of DCM. This DCM rinseate would then be poured into the extraction vessel.

11.3.2. Assemble the apparatus as shown in Figure 1. Add 300-500 mL of methylene chloride to the extractor body. Add 3 to 5 boiling chips to the round bottom distilling flask.

11.3.3. Measure the initial sample pH with wide-range pH paper by dipping a disposable pipette into the sample and wetting the pH paper, and record on the extraction benchsheet. If the sample is a leachate, e.g. TCLP, compare the current pH against the leachate log, and note on the benchsheet if there is any discrepancy.

11.3.4. Weigh the sample container on a balance (± 1 g), taring the sample and container. Add the surrogate spiking solution. Also add matrix spiking solution to any matrix spike/matrix spike duplicate samples. Mix well.

Test	Surrogate Solution		LCS/MS Solution	
	Volume	Name	Volume	Name
Normal	100 µL	OTP/Triacontane	100 µL	Diesel
AFCEE	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	TDB*	Jet Fuel*
NWTPH-Dx	150 µL	OTP/Triacontane	150 µL	Diesel
Si Gel Cleaned	100 µL	OTP/Triacontane	100 µL	Diesel
Hi-Level	500 µL	OTP/Triacontane	500 µL	Diesel
AK102/103	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	100 µL	Motor Oil

Note: Contents of each solution are described in the tables at the end of this SOP.

**If Jet Fuel (JPA, JP4, or JP8) is an analyte of concern, AFCEE requires that it be spiked. Consult with your department manager about concentration/volumes to be used.*

Note: If the sample bottle is completely full, it may be difficult to add the spike solutions to the bottle. In this case, transfer the sample to the extractor and then add the spike.

11.3.4.1. If the entire sample bottle will not be used, measure an aliquot using a graduated cylinder, then transfer the aliquot to the separatory

funnel, then add the spiking solutions to the sample in the separatory funnel.

Note: Alternative methods of measurement of sample volume include: a.) transferring the sample to a measuring cylinder and b.) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.

11.3.4.2. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP. Use 1 L of reagent water for method blanks and LCS. The LCS is spiked with the surrogate and matrix spike solutions, the method blank only with the surrogates.

11.3.5. Use 200 mL of leachate for TCLP, measured in a graduated cylinder. Dilute to about 1 liter with reagent water.

11.3.5.1. For a TCLP method blank, measure 200 mL of the buffer solution used in the leaching procedure. Diluted to about 1 liter with reagent water.

11.3.6. Less than one liter of sample may be used, for highly contaminated samples, or if the reporting limit can be achieved with less than one liter of sample. In this event dilute the sample to about 1 liter with reagent water.

11.3.7. Record spiking volumes, standard IDs, and reagent lots on the benchsheet. Return spiking solutions to the refrigerator as soon as possible.

11.3.8. Inspect the extractor. If the top of the water column is between the top of the sidearm on the boiling flask side and the upper meniscus on the drawing above, go to the next step. Otherwise, add reagent water to the extractor body until the water column has meets the criteria.

Note: The process above is rarely required.

11.3.9. Attach cold condenser (about 12°C). Turn on heating mantle. Inspect joints for leaks once solvent has begun cycling. Extract for 18-24 hours.

11.3.10. Turn off the heating mantle and allow the extractor to cool.

11.3.11. Place a funnel containing 10-20 g of anhydrous sodium sulfate on the Kuderna-Danish (KD) apparatus or other glass container. The funnel can be plugged with glass wool enabling it to hold the granular anhydrous sodium sulfate. Use a small amount of methylene chloride to rinse the funnel and sodium sulfate, discard the rinsate.

11.3.12. Dry the extract in the round bottom flask by filtering it through the sodium sulfate-filled funnel. Rinse the round bottom flask with 20 – 30 mL of methylene chloride and pour it through the funnel to complete the quantitative transfer.

11.3.13. Dispose of the water remaining in the extractor in the LLE waste drum. Methylene chloride remaining in the CLLE body is discarded as waste.

11.3.14. Cover the boiling flask with aluminum foil. Refer to Section 11.7 for concentration and Section 11.10 for cleanup.

11.4. Method 3550B, Solid Extraction by Sonication

11.4.1. Sonicator Tuning

Tune the sonicator according to manufacturer's instructions. The sonicator must be tuned at least every time a new horn is installed.

11.4.2. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.4.3. Decant and discard any water layer on a sediment/soil sample, unless otherwise specified by the client. Homogenize the sample by mixing thoroughly. (See SOP WS-QA-0018). Discard any foreign objects such as sticks, leaves and rocks, unless the client requires extraction of this material. If the sample consists primarily of foreign materials consult with the client (via the Project Manager or Administrator). Document if a water layer was discarded.

11.4.4. Weigh 30 g of sample ± 1.0 g into a 250 mL beaker, 400 mL beaker or glass jar of sufficient size that the sodium sulfate and extraction solvents can be added. Record the weight to the nearest 0.1 g in the appropriate column on the benchsheet. Use 30 g of sodium sulfate for the method blank and LCS.

11.4.5. Mix weighed sample with a spatula or blending rotor, adding enough anhydrous sodium sulfate (approximately 30 g) to be free flowing. (If the sample is not free flowing extraction efficiency may be reduced).

11.4.6. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP.

11.4.7. Add the surrogate spiking solution to each sample, method blank, laboratory control sample (LCS), and matrix spikes. Add the appropriate matrix spiking solution to each matrix spike/matrix spike duplicate (MS/MSD) and LCS. Refer to Table 2 for details of the spiking solutions. Record spiking volumes and standard numbers on the benchsheet. Return spiking solutions

promptly to refrigerator.

Test	Surrogate Solution		LCS/MS Solution	
	Volume	Name	Volume	Name
Normal	100 µL	OTP/Triacontane	100 µL	Diesel
AFCEE	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	TDB*	Jet Fuel*
NWTPH-Dx	150 µL	OTP/Triacontane	150 µL	Diesel
Si Gel Cleaned	100 µL	OTP/Triacontane	100 µL	Diesel
Hi-Level	500 µL	OTP/Triacontane	500 µL	Diesel
AK102/103	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	100 µL	Motor Oil

Note: Contents of each solution are described in the tables at the end of this SOP.

**If Jet Fuel (JPA, JP4, or JP8) is an analyte of concern, AFCEE requires that it be spiked. Consult with your department manager about concentration/volumes to be used.*

11.4.8. Immediately add a minimum of 75-100 mL of methylene chloride to the beaker.

11.4.9. Make sure that all sonicator horns have been cleaned prior to sonicating. To achieve a clean sonicator horn, immerse each sonicator horn in a tri-pour beaker of de-ionized (DI) water for 2-3 pulses. Immediately rinse the horn with acetone to remove any excess water. Finish by rinsing each horn with dichloromethane (DCM). Sonicators are ready for use.

Note: Steps 11.4.6 – 11.4.9 should be performed rapidly to avoid loss of the more volatile extractables.

11.4.10. Place the bottom surface of the sonicator disrupter horn tip approximately ½ inch below the surface of the solvent, but above the sediment layer.

11.4.11. Sonicate for 3 minutes, making sure the entire sample is agitated. If the W-380 or W-385 sonicator is used the output should be set at 6 for the 3/4 inch high gain (Q) horn or 10 for the 3/4 inch standard horn with mode switch on pulse, and percent-duty cycle knob set at 50%.

Note: Do **not** use **Microtip** probe.

WARNING: Hearing protection is required when sonicating samples.

11.4.12. Decant extracts after each sonication into a new 16 oz French square jar.

11.4.13. Note: Do not use old kilned French square jars as collection vessels. These are a potential source of contamination.

11.4.14. Take extra care when decanting/transferring the solvent to the collection

vessel to minimize, as much as possible, the amount of soil and sodium sulfate that is transferred along with the solvent. After the final sonication decant the solvent into the collection vessel and leave as much of the sodium sulfate and soil as possible in the original jar. Cap the collection jar. If concentration of the extracts is not going to be performed on the same day, store the extracts in a flammable refrigerator that is set at 2-6 °C.

11.4.15. Repeat steps 11.4.10 – 11.4.12 two more times with additional 75-100 mL minimum portions of solvent each time. Decant off extraction solvent after each sonication.

11.4.16. Cap the collection container. Refer to Section 11.7 for concentration and Section 11.10 for cleanup.

11.5. Method 3540C, Extraction of Solids with Soxhlet Apparatus

11.5.1. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.5.2. Decant and discard any water layer on a sediment/soil sample. Homogenize the sample by mixing thoroughly. Discard any foreign objects such as sticks, leaves and rocks, unless the client requires extraction of this material. If the sample consists primarily of foreign materials consult with the client. Document on benchsheet if a water layer was discarded.

11.5.3. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.5.4. Weigh 15 g of sample ± 1.0 g into a beaker or glass jar, recording the weight to the nearest 0.1 g on the benchsheet. Use 15 g of sodium sulfate for the method blank and LCS. Add 15 g of anhydrous sodium sulfate to the samples and mix well. The mixture should have a free flowing texture. If not, add more sodium sulfate. Add the sample/sodium sulfate mixture to a Soxhlet thimble, but do not pack the thimble tightly. The extraction thimble must drain freely for the duration of the extraction period.

11.5.4.1. Sample weights less than 15 g but over 5 g may be used if the appropriate reporting limits can be met.

11.5.5. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP, using sodium sulfate as the matrix. The weight of sodium sulfate used should be approximately the weight of soil used in each sample.

11.5.6. Add the surrogate spiking solution to each sample, method blank, laboratory

control sample (LCS), and matrix spikes. Add the appropriate matrix spiking solution to each matrix spike/matrix spike duplicate (MS/MSD) and LCS. Refer to Tables 3 - 6 for details of the spiking solutions. Record spiking volumes and standard numbers on the benchsheet. Return spiking solutions promptly to refrigerator.

Test	Surrogate Solution		LCS/MS Solution	
	Volume	Name	Volume	Name
Normal	100 µL	OTP/Triacontane	100 µL	Diesel
AFCEE	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	TDB*	Jet Fuel*
NWTPH-Dx	150 µL	OTP/Triacontane	150 µL	Diesel
Si Gel Cleaned	100 µL	OTP/Triacontane	100 µL	Diesel
Hi-Level	500 µL	OTP/Triacontane	500 µL	Diesel
AK102/103	100 µL	OTP/Triacontane	100 µL	Diesel
	100 µL	OTP/Triacontane	100 µL	Motor Oil

Note: Contents of each solution are described in the tables at the end of this SOP.

**If Jet Fuel (JPA, JP4, or JP8) is an analyte of concern, AFCEE requires that it be spiked. Consult with your department manager about concentration/volumes to be used.*

11.5.7. Place approximately 300 mL of methylene chloride into a 500 mL round bottom flask containing one or two clean boiling chips. Attach the flask to the extractor and extract the sample for 16-24 hours at 4-6 cycles per hour. Check the system for leaks at the ground glass joints after it has warmed up.

11.5.8. Allow the extract to cool after the extraction is complete. Collect all solvent in the round bottom flask. Disassemble by gently twisting the Soxhlet from the flask. Do not force the glassware apart.

11.5.9. Collect the dried extract in a KD or other glass container. Rinse the flask, which contained the solvent extract with 20-30 mL of methylene chloride and add it to the funnel to complete the quantitative transfer.

11.5.10. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.7 for concentration and Section 11.10 for cleanup.

11.6. Method 3580A, Waste Dilution

11.6.1. This method is used for materials that are soluble in an organic solvent.

11.6.2. Transfer 10 mL of the solvent to be used for dilution into a Teflon capped vial. Mark the meniscus on the vial, then discard the solvent.

11.6.3. Tare the vial, then transfer approximately 1g of sample to the vial. Record

the weight to the nearest 0.1 g.

11.6.4. Add the surrogate solution (Table 2). If performing matrix spikes, add the spiking solution.

Surrogates		**LCS/MS**	
OTP	300 µL	Diesel	300 µL
OTP/Triacontane (AFCEE only)		TDB*	Jet Fuel*

Note: Contents of each solution are described in the tables at the end of this SOP.

**If Jet Fuel (JPA, JP4, or JP8) is an analyte of concern, AFCEE requires that it be spiked. Consult with your department manager about concentration/volumes to be used.*

11.6.5. Dilute to 10 mL with methylene chloride.

11.6.6. Add surrogate solution to a test tube and dilute to 10 mL with solvent. This is the method blank.

11.6.7. Add surrogate solution and matrix spike solution to a test tube and dilute to 10 mL with solvent. This is the LCS. Repeat to make an LCSD if necessary.

11.6.8. Label the sample, which is now ready for cleanup or analysis.

11.7. Concentration

According to the type of sample and any cleanup procedures needed, different final solvents and volumes will be required. Below are the "normal" final volumes for tests covered by this SOP:

Test	**Final Volume**	**Split?**
Normal	3.0mL	No
NWTPH-Dx	5.0mL	No
Si Gel Cleaned	3.0mL	1.5mL for cleaning, 1.5mL for archive.
Hi-Level	15mL	No
AK102/103	3.0 mL	No

11.8. Kuderna-Danish (KD) Method

11.8.1. Loosely plug the stem of a 75mm x 75mm glass funnel with glass wool. (Note: Only use glass wool that has been soxhlet rinsed with DCM for 18 hours.) Add 10-20g of kilned anhydrous sodium sulfate to the funnel cup. RINSE the entire funnel cup set-up with DCM until the sodium sulfate is completely immersed by the DCM. This is imperative to remove possible contaminants.

11.8.2. Place the prepared funnel cup into a ring stand over the KD flask. Decant and filter extracts through the prepared funnel into the KD apparatus. Make sure to rinse the French square jar 3 times with DCM, decanting each rinse through the funnel cup into the KD flask. This procedure helps to ensure adequate analyte recovery.

11.8.3. Assemble a Kuderna-Danish concentrator as shown in Figure 2 by attaching a 10 mL concentrator tube to the 500 mL KD flask. Transfer the sample to the KD flask. Add one or two DCM rinsed boiling chips and the extract to be concentrated to the KD flask, and attach a three ball Snyder column. Add approximately 1 mL of clean methylene chloride to the top of the Snyder column (this is important to ensure that the balls are not stuck and that the column will work properly). Attach the solvent vapor recovery device to the top of the Snyder column.

11.8.4. Place the KD apparatus on a water bath (80-85ºC) so that the tip of the concentrator tube is submerged. The water level should not reach the joint between the concentrator and the KD flask. At the proper rate of distillation, the balls will actively chatter but the chambers should not flood.

11.8.5. Concentrate to about 6 mL.

Note: It is very important not to concentrate to dryness, as analytes will be lost.

11.8.6. Remove the KD apparatus from the water bath and allow to cool for a minimum of 10 minutes. If the level of the extract is above the level of the concentrator tube joint, continue to distill the solvent as necessary. Again, allow the KD flask to cool for a minimum of 10 minutes. Proceed with Section 11.8.7, unless cleanups are requested. For cleanups, proceed to Section 11.10.

11.8.7. Quantitatively transfer the extract to a 16 mL test tube. Pipet the extract into the tube, then rinse the KD tube with 1-2 mL of methylene chloride, and add the rinsate to the test tube. Repeat twice with fresh portions of solvent. If the volume in the tube is greater than the final volume required, proceed to Section 11.9. Otherwise, adjust to the final volume by adding methylene chloride.

11.9. Nitrogen Evaporation to Final Concentration

11.9.1. Place the tube in a water bath that is no warmer than 35°C and evaporate the solvent using a gentle stream of nitrogen. The nitrogen flow will form a slight depression on the surface of the solvent, but should not create splattering of the extract.

11.9.2. During the course of the evaporation rinse the sides of the evaporation tube

twice with approximately 1 mL of clean solvent. The first rinse should be about half way through the process, with the second rinse when the solvent volume gets close to 3.0 mL.

11.9.3. When the volume is slightly below 3.0 mL, remove the test tube from the n-evap bath. Compare the volume to that of the calibrated reference, and carefully add solvent to make the final volume.

Note: It is very important not to concentrate to dryness, as analytes will be lost.

Note: The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.

11.9.4. If requested, proceed to the cleanup steps. Otherwise, extracts are ready for analysis.

11.10. Cleanup Techniques

The following techniques may be used to remove interfering peaks, and /or to remove materials that may cause column deterioration and/ or loss of detector sensitivity. In general, these cleanups are applied only when the client requests them.

Silica Gel cleanup (Section 11.11) is used to remove interferents of biological origin from the extract.

Northwest cleanup (Section 11.12) is an acid and silica gel cleanup, applied at client request to comply with requirements for the states of Oregon and Washington.

WARNING: Sulfuric acid cleanup must not be performed on any matrix that may have water present as a violent reaction between the acid and water may result in acid exploding out of the vessel.

11.11. Silica Gel Cleanup

11.11.1. Adjust the extract volume to 3.0 mL with methylene chloride.

11.11.2. 1.5 ml is silica gel cleaned, 1.5 mL is archived.

11.11.3. To a "Monstr-pette" (Chase Scientific Glass 5.75 inch) plugged with a small amount of glass wool, add ~1.5 g activated silica gel (baked 8 hours at 150-160 deg C). Top with a small layer of kilned sodium sulfate.

Note: If a “Monstr-pette” is not available, a 5 mL graduated pipette may be used.

11.11.4. Rinse column by filling to the top with methylene chloride and allowing the methylene chloride to collect in a 16 mL test tube. Repeat for a total of 3 rinses. Positive pressure using a pipette bulb may be used. Discard methylene chloride rinse and test tubes.

11.11.5. Add 1.5 mL sample to the column, and collect in a clean 16 mL test tube.

Elute sample with ~6 mL methylene chloride. A pipette bulb may be used to speed the sample through the column. Adjust the volume to 1.5 mL under nitrogen (See Section 11.9.)

11.11.6. All samples including the batch QC (MB/LCS/LCSD) and field QC (MS/MSD) are cleaned.

11.12. Northwest Cleanup

11.12.1. Adjust the extract volume to 5.0 mL with methylene chloride.

11.12.2. Add approximately 0.5 mL of concentrated sulfuric acid to the extract and cap.

WARNING: There must be no water present in the extract or the reaction may shatter the sample container.

11.12.3. Shake or vortex for about one minute and allow it to settle. (Centrifuge if necessary)

11.12.4. Remove the sample extract (top layer) from the acid using a Pasteur pipet and transfer to a clean culture tube.

CAUTION: It is not necessary to remove all the extract since the final volume is already determined. Transfer of small amounts of sulfuric acid along with the extract will result in extremely rapid degradation of the chromatographic column.

11.12.5. Add approximately 0.2 g silica gel to the extract.

11.12.6. Shake or vortex for about one minute and allow it to settle. (Centrifuge if necessary)

11.12.7. Remove the sample extract from the silica gel using a Pasteur pipette and transfer to a clean culture tube.

11.12.8. Repeat steps 11.12.2 through 11.12.7.

11.12.9. Mark the top and bottom meniscus on the tube, and transfer to the instrument area.

11.12.10. Dispose of the sulfuric acid waste to the waste sulfuric acid drum for recycling.

12. CALCULATIONS/DATA REDUCTION

12.1. Not applicable.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP SAC-QA-0006. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration

The laboratory must make an initial demonstration of capability for each individual method. Demonstration of capability for both soil and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be less than or equivalent to the LCS samples.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these to the laboratory generated QC Limits.

13.4. If any analyte does not meet the acceptance criteria the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste

disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Extracted aqueous/TCLP leachate samples contaminated with methylene chloride are collected at the fume hood in a 5-gallon or smaller carboy. If the samples are not at a neutral pH, add small quantities of sodium bicarbonate to bring the waste to neutral. Stir well. Once neutralized, immediately pour the carboy contents into a blue plastic LLE drum in the H3 closet. When full to between one and four inches of the top, or after no more than 75 days, move the LLE drum to the waste collection area for shipment.

15.2. Extracted soil samples, thimbles, used sodium sulfate, glass wool or filter paper contaminated with methylene chloride and acetone. Dump the extracted soil and thimbles into an orange contaminated lab trash bucket. When the bucket is full or at the end of the day, tie the plastic bag liner shut and put the lab trash into the appropriate steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.3. Assorted flammable solvents and methylene chloride waste from various rinses. Collect the waste solvents in tripours during use. Empty the tripours into a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the steel solvent drum in the H3 closet. When full to between two and six inches of the top, or after no more than 75 days, move the steel drum to the waste collection area for shipment.

15.4. Waste methylene chloride remaining in the bottom of the Continuous Liquid Liquid Extractor Body, if that extraction method is used. Decant the remaining DCM in the CLLE to separate it from the extracted sample. Collect the waste methylene chloride in tripours during use. Empty the tripours into a 1-liter to 4-liter carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the steel solvent drum in the H3 closet. When full to between two and six inches off the top, or after no more than 75 days, move the steel drum to the waste collection area for shipment.

15.5. Miscellaneous disposable glassware and silica gel contaminated with acids, caustics, solvents and sample residue. Dump the material into a yellow contaminated lab trash. When the bucket is full or at the end of the day, tie the plastic bag liner shut and put the lab trash into the appropriate steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.6. Used sulfuric acid from the Northwest cleanup. Collect the used sulfuric acid in empty, 2.5-liter, plastic coated jars. When full or after one year, whichever comes first, transfer these jars to the waste collection area for shipment.

15.7. Expired standards must be rotated out of the laboratory for disposal to the vial waste stream.

16. REFERENCES/CROSS REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III

Method 3500B, Organic Extraction and Sample Preparation, Revision 2, December 1996

Method 3510C, Separatory Funnel Liquid Liquid Extraction, Revision 3, December 1996

Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996

Method 3540C, Soxhlet Extraction, Revision 3, December 1996

Method 3550B, Ultrasonic Extraction, Revision 2, December 1996

Method 3580A, Waste Dilution, Revision 1, July 1992

Method 3600C, Cleanup, Revision 3, December 1996

Method 3630C, Silica Gel Cleanup, Revision 3, December 1996

16.2. Leaking Underground Fuel Tank Field Manual, State of California, October, 1989

16.3. Underground Storage Tanks Procedures Manual, Alaska Department of Environmental Conservation, November 7, 2002; Appendix D

16.4. Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997

16.5. Alaska Department of Environmental Conservation, April 8, 2002; Methods AK102.0 and AK103.0

16.6. Analytical Methods for Petroleum Hydrocarbons, Washington State Department of Ecology, June 1997, Method NWTPH-Dx

17. METHOD MODIFICATIONS

17.1. Some surrogate spiking concentrations are modified from those recommended in SW-846, in order to make the concentrations more consistent with the calibration levels in the determinative methods.

17.2. Aqueous sample volumes are determined by weight.

18. ATTACHMENTS

18.1. Table 1- Surrogate Spike Components

18.2. Table 2 – LCS/Matrix Spike Solution Components

18.3. Table 3 – West Sacramento Method 8015B Extraction Summary

19. REVISION HISTORY

19.1. WS-OP-0004, Revision 4.3, Effective 12/14/2012

19.1.1. Removed reference to filter paper as a plug for sodium sulfate funnels. Only glass wool is used as filter paper causes contamination.

19.1.2. Editorial changes.

19.2. WS-OP-0004, Revision 4.2, Effective 2/29/2010

19.2.1. Added Section 1.3: When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 "DoD QSM and AFCEE QAPPP Implementation" must be checked and incorporated.

19.2.2. Added Sections 11.2.3.1 and 11.3.1.1: If the sample bottle contains a layer of sediment greater than approximately ½" in depth, contact the department manager and the project manager to determine how to proceed with the sample extraction. Options may include the following:

a) Decanting and extracting only the liquid fraction in a separatory funnel before adding the surrogate and/or spike solutions.
b) Adding the surrogate and/or spike solutions to the sample with the sediment still in the original sample container.
c) Processing the aqueous portion as described in a) along with creating a new sample id for the soil matrix. The sample bottle would then be rinsed with 60 mL of DCM, spiked with an appropriate volume of surrogate solution and shaken for 3 minutes. The addition of 60 mL of DCM will be repeated 2 more times and all solvents combined to create a second extract for the sample that is to be added to the extraction batch of water samples

NOTE: In the case of option "b", after adding the appropriate surrogates/spikes, the sample would be gently swirled for mixing purposes and then gently poured into the separatory funnel, thus minimizing the amount of sediment transferred to the extraction v vessel during the process. The original sample container would then be rinsed with 60 mL of DCM. This DCM rinseate would then be poured into the extraction vessel.

19.3. WS-OP-0004, Revision 4.1, Effective 1/15/2010

19.3.1. Updated Sections 11.4 and 11.8 to reflect current extract decanting procedures.

19.3.2. Inserted Section 11.4.8 "Make sure that all sonicator horns have been cleaned prior to sonicating. To achieve a clean sonicator horn, immerse each sonicator horn in a tri-pod beaker of de-ionized (DI) water for 2-3 pulses. Immediately rinse the horn with acetone to remove any excess water. Finish by rinsing each horn with dichloromethane (DCM). Sonicators are ready for use.

19.3.3. Changed all surrogate references in Section 11 from OTP to OTP/Triacontane.

19.4. WS-OP-0004, Revision 4, Effective 10/1/2008

19.4.1. Updated to TestAmerica format.

19.4.2. Added HTs for AK102/103, spiking instructions for AFCEE.

19.5. SAC-OP-0004, Revision 3.2, Effective 4/16/2007

19.5.1. Updated Section 11.2.5 to reflect current practice.

Table 1
Surrogate Spike Solution Components

Solution	Solvent	Compounds	Conc. (µg/mL)
OTP	Acetone	o-Terphenyl	400
Triacontane	90:10 Acetone:DCM	n-triacontane-d62	500

Table 2

LCS/Matrix Spike Solution Components

Solution	Solvent	Component	Conc. (µg/mL)
Diesel	Acetone	Diesel fuel #2	3,000
Motor Oil	Acetone	Motor Oil	9,000

Table 3 – West Sacramento Method 8015B Extraction Summary

Spiking and final volumes by test type (applicable to all matrices):

	OTP µL	Diesel µL	MO µL	Triacontane µL	Final Volume / Cleanup
Normal	100	100	NA	NA	3.0 mL / none
Hi-Level	500	500	NA	NA	15 mL / none
Si Gel	100	100	NA	NA	1.5 mL cleaned, 1.5 mL to archive
NWTPH-Dx	150	150	NA	NA	5.0 mL – acid/silica cleaned
AK 102/103	100	100	100	100	3.0 mL / none

Extraction parameters by extraction type:

	Sample Amount	Extract Solvent Volume	Extraction Time	Comments
Aqueous (SEPF)	1 L	3 x 60 mL	2 min shake, 10 min rest	
Aqueous (CLLE)		300-500 mL	18-24 hours	
Solid (Sonication)	30 g	3 x 75-100 mL	3 min	
Solid (Soxhlet)	15 g	300 mL	16-24 hours	Spike & final volume are ½ of normal!
Waste Dilution	1 g	10 mL	NA	Don't concentrate.
Wipes	1 wipe	3 x 100 mL	16-24 hours	

Figure 1 — LLE Setup (See Section 11.3 for description)

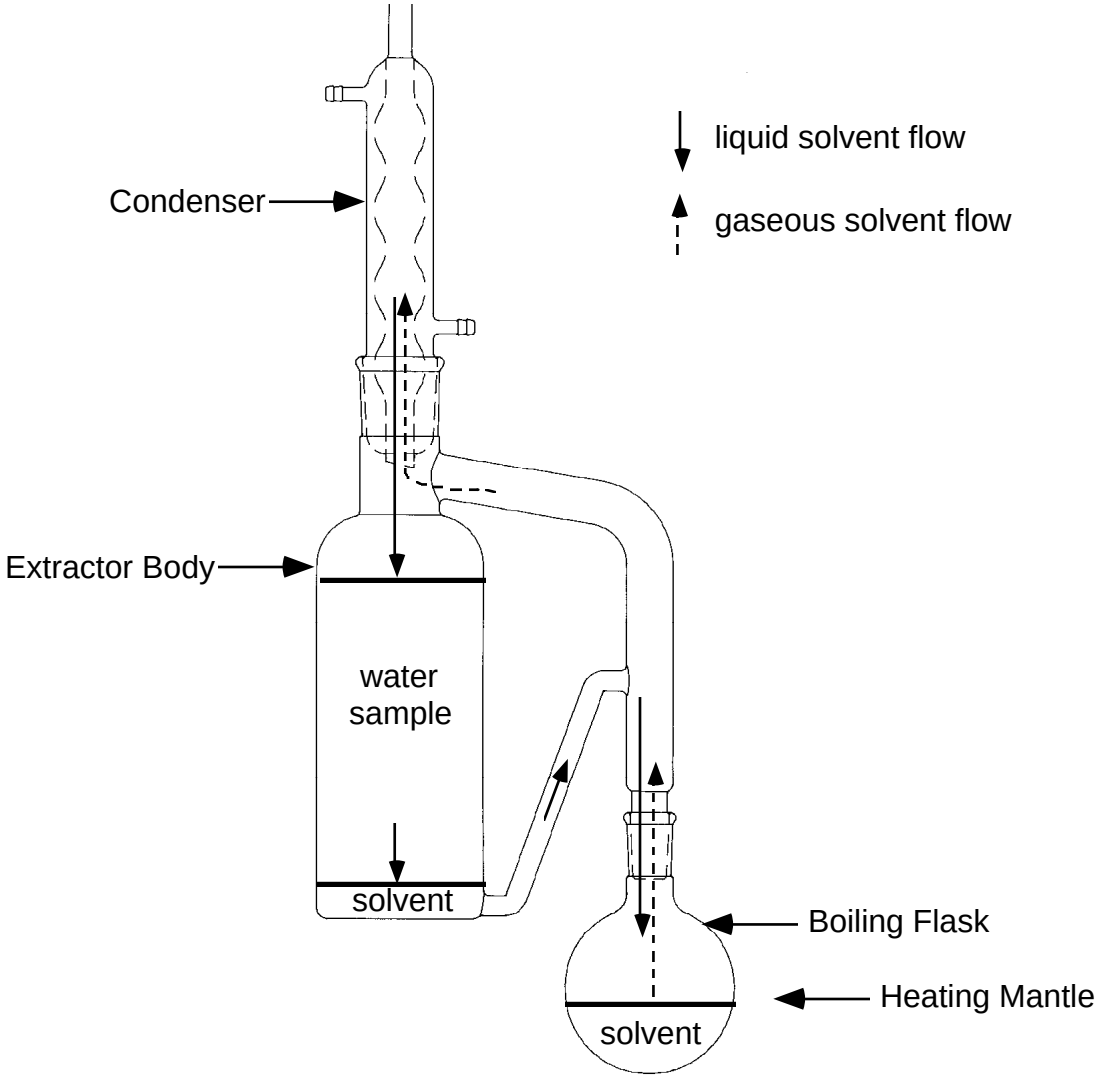
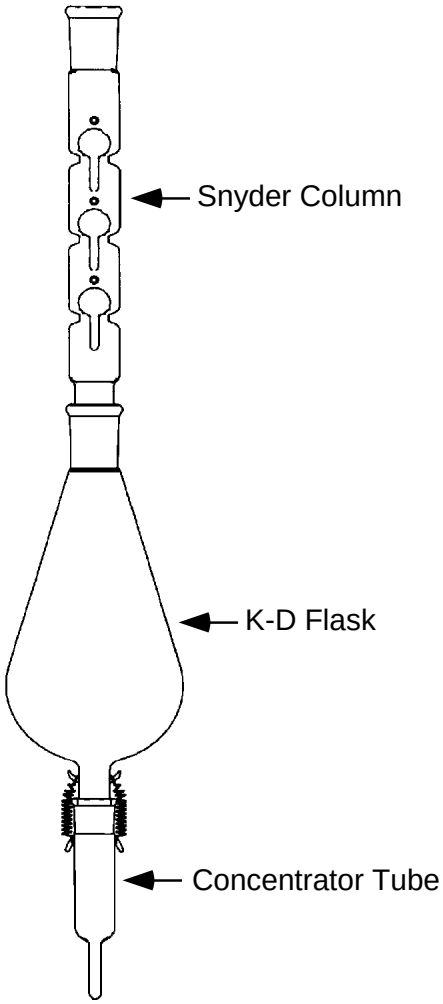


Figure 2 — KD Setup (See Section 11.8 for description)



Title: Determination of Anions by Ion Chromatography [EPA Method 300.0-Part A, SW-846/Method 9056]

Approvals (Signature/Date):

Elizabeth Nguyen Date Technical Manager	Joe Schairer 4/9/12 Date Health & Safety Manager / Coordinator
Douglas Weir 4/11/2012 Date Quality Assurance Manager	Karla Buechler 4/12/12 Date Laboratory Director

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1. SCOPE AND APPLICATION

1.1. This SOP describes procedures for analysis of inorganic anions by Ion Chromatography (IC) using EPA 600/Method 300.0 Part A and SW-846/Method 9056 as method references.

1.2. Applicable Matrices:

1.2.1. Drinking water, surface water, mixed domestic and industrial wastewaters, groundwater, and reagent water.

1.2.2. Solutions collected from bomb combustion extraction of solid waste samples by SW-846/Method 5050.

1.2.3. Solids after extraction by deionized water leaching procedure as outlined in SOP WS-WC-0049 (based on Method 300.0, Section 11.7).

1.2.4. Other leachates (when no acetic acid is used).

1.3. This method covers the determination of the following inorganic anions as well as the retention times (recommended, may vary depending on the eluent strength), individual reporting limits, and analytical linear ranges:

Anions	**Approximate Retention time (min.) with ±% window size**		**Water Reporting Limit (mg/L)**	**Soil Reporting Limit (mg/kg)**	**Analytical Linear Range (mg/L)**
Fluoride, (F^-)	2.0	5%	0.5	2.5	0.5 - 50
Chloride, (Cl^-)	2.9	5%	1.0	5.0	1 - 100
Nitrite, (as N)	3.6	5%	0.05	0.25	0.05 - 10
Bromide, (Br^-)	4.3	5%	0.5	2.5	0.5 - 50
Nitrate, (as N)	5.0	5%	0.05	0.25	0.05 - 10
Ortho-Phosphate (as P)	6.2	5%	0.20	1.0	0.20 - 20
Sulfate, (SO_4)	7.1	5%	1.0	5.0	1 - 100

1.4. The analytical time per injection is approximately 10 minutes from injection to chromatogram printout.

1.5. This method is recommended for use only by or under the supervision of analysts experienced in the use of ion chromatography and in the interpretation of the resulting ion chromatograms.

1.6. When undertaking projects for Department of Defense (DoD) the relevant criteria in QA Policy WS-PQA-021 “DoD QSM and AFCEE QAPP Implementation” must be checked and incorporated.

2. SUMMARY OF METHOD

2.1. A small volume of sample, typically 2 to 5 mL, is injected into an ion chromatograph to flush and fill a constant volume in the sample loop. The sample is then injected into a stream of carbonate-bicarbonate eluent and pumped through three different ion exchange columns and into a conductivity detector.

2.2. Two columns, the guard column and a separator column, are packed with a low-capacity, strongly basic anion exchanger. Ions are separated into discrete bands based on their affinity for the exchange sites of the resin. The suppressor device reduces the background conductivity of the eluent to a low or negligible level and converts the anions in the sample to their corresponding acids. The separated anions in their acid form are measured using an electrical-conductivity cell.

2.3. Anions are identified based on their retention times and quantified using the peak area in comparison to the calibration curve generated from known standards.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. Large amounts of anion can interfere with the peak resolution of an adjacent anion. Dilute the sample until the interfering anions no longer affect the ions of interest.

4.2. Samples that contain particulates larger than 0.45 microns and reagent solutions that contain particles larger than 0.20 microns require filtration to prevent damage to instrument columns and flow systems. Particulates can be separated by filtering the samples, standards, or reagents through a filter syringe with a 0.45 micron filter cartridge.

4.3. Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or an elevated baseline in ion chromatographs.

4.4. Low molecular weight organic acids, such as formate, acetate, propionate, etc… have retention times similar to fluoride and can make it difficult to quantify fluoride content of the sample.

4.5. The water dip or negative peak that elutes near the front end can interfere with the fluoride peak. It can be eliminated by the addition of the equivalent of 1 mL of concentrated eluent to 100 mL of each standard and sample.

4.6. Any anion that is not retained in the column or only slightly retained will elute in the area of fluoride and interfere. Known coelution is caused by carbonate and other small organic anions. At concentrations of fluoride above 1.5 mg/L, this interference may not be significant.

4.7. Similar interference to fluoride by low molecular weight organic acids such as formate, acetate, propionate, etc. can make it difficult to quantify fluoride content of the sample.

4.8. The acetate anion elutes early during the chromatographic run. The retention times of target analytes shift when large amounts of acetate are present. Therefore, this method is not recommended for leachates of solid samples when acetic acid is used for pH adjustment.

4.9. Nitrite may be oxidized to form nitrate by bacteria in water solutions. It is recommended that standard solutions of nitrite and nitrate be stored separately until just prior to analysis.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toes, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Sodium Fluoride is Highly Toxic.

5.1.2. Exercise caution when using syringes with attached filter assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

5.1.3. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. PVC, latex and nitrile gloves provide adequate levels of protection against the chemicals used in this SOP.

5.1.4. Exposure to chemicals must be maintained as low as reasonably achievable,

therefore all samples must be opened, transferred and prepared in a fume hood. Reagent and waste containers will be kept closed unless transfers are being made.

5.1.5. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts, and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials Section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Potassium Bromide		None Established	Inhalation of dust may cause irritation to respiratory tract, with coughing. Dust may irritate skin, with redness and itching. Solutions may cause redness and burns.
Sodium Fluoride	Poison	2.5 Mg/M^3-TWA as F	**Highly Toxic.** Causes severe irritation to the respiratory tract, symptoms may include coughing, sore throat, and labored breathing. Causes irritation, with redness and pain. Solutions are corrosive. Eye irritant! May cause irritation and serious eye damage. Effects may not appear immediately.
Sodium Nitrite	Oxidizer Poison Reactive	None	**Danger! Strong oxidizer and toxic material. Contact with other material may cause fire. Heat, shock, or contact with other material may cause fire or explosive decomposition.** Causes irritation to the respiratory tract and systemic poisoning. Can irritate the mouth, esophagus, stomach, etc. Excessive amounts affect the blood and blood vessels. Signs and symptoms of nitrite poisoning include intense cyanosis, nausea, dizziness, vomiting, collapse, spasms of abdominal pain, rapid heart beat, irregular breathing, coma, convulsions, and death due to circulatory collapse. Causes irritation, redness and pain to the skin and eyes. May be absorbed through the skin causing systemic poisoning.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Ion chromatograph - This method uses an IC instrument manufactured by Dionex, Model # ICS-1000 utilizing a Windows® based Chromeleon® Chromatography Workstation (Rev. 6.5) for instrument control, digital data collection and processing software. It is equipped with an injection valve, auto sampler, pump with a flow rate of 1.2 mL/min., integrator, a 10-uL loop, and set up with the following components:

6.1.1. Anion guard column: Placed before the separator column to protect the separator column from being fouled by particulates or certain organic constituents, (Ion Pac AG22A, 4mm, Dionex P/N 072784).

6.1.2. Anion separator column: Packed with low-capacity pellicular anion exchange resin that is styrene divinylbenzene-based, (Ion Pac AS22A, 4mm, Dionex P/N 072782).

6.1.3. Anion Self Regenerating Suppressor: Capable of converting the eluent and separated anions to their respective acid forms, (ASRS 300, 4mm, Dionex P/N 04554).

6.1.4. Detector: Flow through conductivity cell measures electrical conductance of analyte ions, (D56, Dionex P/N 057985).

6.2. Balance - Analytical, capable of accurately weighing to the nearest 0.0001 g.

6.3. Syringe, disposable, 2-10 mL capacity and equipped with male pressure fitting.

6.4. 0.45 micron acrodisk filter.

6.5. IC sample vial and filter caps - at least 5 mL capacity

6.6. Test strips for Nitrite, Nitrate, Chloride, and Sulfate.

6.7. Various analytical glassware of different sizes - graduated cylinder, volumetric flask, pipettes, etc.

6.8. Preventative and routine maintenance as described in the “Schedule of Routine Maintenance” in the QAM.

7. REAGENTS AND STANDARDS

7.1. Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is

of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2. Reagent Water: Distilled or deionized water free of the anions of interest. Water shall contain particles no larger than 0.20 micron, have maximum conductivity of 1µmhos/cm, and have a maximum resistively of at least 1 Mohm/cm at 25°C (per SOP WS-QA-0014).

7.3. A commercially available stock eluent, such as the AS22 Eluent Concentrate (P/N 0963965) – 0.45 M Na_2CO_3 / 0.14 M $NaHCO_3$. from Dionex may be purchased. Follow manufacturer's instructions to obtain 4.5 mM Sodium Carbonate/1.4 mM Sodium Bicarbonate eluent working solution.

7.3.1. As an alternative, Eluent Stock Solution: Dissolve 47.7 g Na_2CO_3 and 11.76 g $NaHCO_3$ in approximately 500 mL reagent water in a 1000 mL flask. Bring to a final volume of 1000 mL with reagent water. This solution is good for one year.

7.3.2. Eluent Working Solution: Add 20 mL of the eluent stock to approximately 1000 mL of reagent water in a 2000 mL volumetric flask. Bring to a final volume of 2000 mL. This solution expires 6 months from the date of preparation.

7.4. Stock Mixed Anion Calibration Standards: Commercially available, custom mixed anion standards, such as AccuStandard IS-14976-R3. These include AccuStandard custom IC mixes IS-14936 and IS-14937. This standard contains 500µg/L Fluoride, 500 µg/L Chloride, 500 µg/L Bromide, 100 µg/L Nitrate (as N), 200 µg/L Phosphate (as P), and 500 µg/L Sulfate, at certified concentrations. This is stored at room temperature, and expires one year from the open date, or the vendor expiration date, whichever is lesser. The current calibration curve values do not allow for calibration curve preparation from a single stock Mixed Anion Calibration Standard solution.

7.5. Stock Single Analyte Calibration Standards, 1000 mg/L (1 mg/mL): Stock standards are purchased as certified solutions. Stock standard solutions are stored at room temperature and expire one year from the open date, or the vendor expiration date, whichever is lesser.

7.6. Stock Mixed Anion Reference Standard: Commercially available, ready-to-use custom mixed anion standard, such as AccuStandard custom IC mix IS-16268-R2. This standard is from a different source than the Stock Mixed Anion Standard Calibration Solutions. This standard contains 15 µg/L Fluoride, 15 µg/L Chloride, 15 µg/L Bromide, 3.15 µg/L Nitrate (as N), 6 µg/L Phosphate (as P), and 15 µg/L Sulfate, at certified concentrations. This is stored at room temperature, and expires one year from the open date, or the vendor expiration date, whichever is lesser.

7.7. Stock Single Analyte Reference Standards, 1000 mg/L (1 mg/mL) are also purchased as certified solutions. These standards are from a different source than the Stock Single Analyte Calibration Standards. Stock Standard solutons are stored at room temperature and expire on year from the open date, or the vendor expiration date, whichever is lesser.

7.8. Stability of Stock Standard Solutions: All purchased certified stock solutions are good for one year of opening, or manufacturer expiration date, whichever is lesser.

7.9. Anion Working Calibration and Reference Standards: A reagent blank consisting of reagent water, and a series of standards with different levels of concentrations of all anions combined are prepared from the Stock Mixed Anion Calibration and Reference Standards if applicable (Sections 7.4 and 7.6, respectively). Alternatively, the standards may be prepared from Stock single analyte Calibration and Reference Standards (Sections 7.5 and 7.7, respectively). These combination anion solutions are used to calibrate the instrument monthly or when columns or eluent strengths are changed, or when new eluent stock solution is made. Working standards are to be stored at 4 ± 2°C.

7.10. See the following tables for Standard Curve Levels and Preparation recipes.

Table 1. Calibration and Reference Concentration Levels, mg/L

ANIONS	ICV[a]	Level 0[b]	Level 1	Level 2	Level 3[c]	Level 4
		Autocal 0	Autocal 1R	Autocal 2R	Autocal 3R	Autocal 4R
Fluoride (F^-)	7.5	0.0	0.5	5	10	20
Chloride (Cl^-)	7.5	0.0	1.0	5	10	20
Nitrite (NO_2^- as N)	3.75	0.0	0.05	0.5	5	10
Bromide (Br^-)	7.5	0.0	0.5	5	10	20
Nitrate (NO_3^- as N)	1.875	0.0	0.05	0.5	5	10
Ortho-Phosphate (as P)	3	0.0	0.2	1	5	10
Sulfate (SO_4^{2-})	7.5	0.0	1.0	5	15	50

[a] Prepared from Stock Mixed Anion Reference Standard and Nitrite Stock Single Analyte Reference Standard. Alternately prepared from Stock Single Analyte Reference Standards.
[b] Level 0 is reagent water
[c] Mid-level standard for continuing calibration verification (CCV)

Table 2. Standard Curve Preparation Recipe (mL[a])								
Anions	ICV[b]	ICV[c] Alt	ICV[d] Alt2	Level 1 AutoCal 1R	Level 2 AutoCal 2R	Level 3[e] AutoCal 3R	Level 3 [f] Alt	Level 4 AutoCal 4R
Final Volume	100	100	5	500	100	250	100	100
Fluoride (F^-)	0.75[b]	NA	NA	0.25	0.5	2.5	1	2
Chloride (Cl^-)	0.75[b]	NA	NA	0.5	0.5	2.5	1	2
Nitrite (NO_2 as N)	0.375[b]	NA	NA	0.025	0.05	1.25	0.5	1
Bromide (Br^-)	0.75[b]	NA	NA	0.25	0.5	2.5	1	2
Nitrate (NO_3^- as N)	0.1875 [b]	NA	NA	0.025	0.05	1.25	1	1
Ortho Phosphate (as P)	0.30 [b]	NA	NA	0.1	0.1	1.25	0.5	1
Sulfate (SO_4^{2-})	0.75[b]	NA	NA	0.5	0.5	6.25	2.5	5
Stock Mixed Anion Reference Standard	NA	50	1.5	NA	NA	NA	NA	NA
Nitrite (NO_2 as N)[g]	NA	0.375	0.01875	NA	NA	NA	NA	NA

[a] Prepared from 1000 µg/L Stock Single Analyte Calibration Standards except for ICV, ICV Alt and ICV Alt 2.

[b] ICV prepared from 1000 µg/L Stock single Analyte Reference Standards .

[c] ICV Alt prepared from Stock Mixed Anion Reference Standard and Nitrite 100 µg/L Stock Single Analyte Reference Standard.

[d] ICV Alt2 prepared daily as needed from Stock Mixed Anion Reference Standard and Nitrite 1000 µg/L Stock Single Analyte Reference Standard. This meets CWA and NPDESAS requirements.

[e] Mid-level standard for Continuing Calibration Curve (CCV).

[f] Level 3 Alt is prepared daily as needed. Level 3 Alt can be prepared monthly from all anions **EXCEPT** Nitrite, which must be added daily. In this case 0.025mL of 1000µg/L Nitrite Stock Single Analyte Calibration Standard is added to a 5mL aliquot of the Level 3 Alt solution to generate the daily working standard/CCV. This meets CWA and NPDES requirements.

[g] This solution must be a 1000 µg/L Stock Single Analyte Reference Standard.

7.11. Preparation of Calibration Standard Curve Solutions:

7.11.1. Level 0- Reagent water.

7.11.2. Level 1R- 4R and ICV solutions are prepared using the standards and volumes indicated in Table 2.

7.11.3. Working Reference Solution: A second-source reference solution is prepared as needed. This solution is analyzed daily as the Initial Calibration Verification (ICV). The second source Working Reference Solution (ICV) is at or near the mid-point of the calibration range.

7.12. Stability of Anions Working Calibration and Reference Standards: Based on the laboratory's stability study, all of the combined solutions in Tables 1 and 2 are stable for one month. Working Calibration Reference Standards must be prepared fresh daily (specifically the Nitrite component) when samples are being processed under the Clean Water Act (CWA) or NPDES programs. This includes the CCV and ICV.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Samples should be collected in pre-cleaned plastic and glass bottles. The volume collected should be sufficient to ensure a representative sample, allow replicate analysis when needed and minimize sample disposal.

8.2. Preservation, holding time and minimum sample requirements are listed in the following table:

TABLE 3
Preservation, Holding Time, and Minimum Sample Size

Analyte	Preservation	Water Holding Time[(e)]	Minimum Sample Size	
			Water	Soil
Fluoride (F^-)	4ºC	28 days	50 mL	50 g
Chloride (Cl^-)	4ºC	28 days	50 mL	50 g
Nitrite (as N)	4ºC	48 hours	50 mL	50 g
Bromide (Br^-)	4ºC	28 days	50 mL	50 g
Nitrate (as N)	4ºC	48 hours	50 mL	50 g
Ortho-Phosphate (as P)	4ºC	48 hours	50 mL	50 g
Sulfate (SO_4)	4ºC	28 days	50 mL	50 g

[(e)] Holding times are measured from date of sampling.

8.3. Holding times for soils are measured from the date/time of the generation of the DI water leachate. The holding time of the leachate follows that of the water samples holding time.

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability - See Section 13.

9.2. Batch definition-The batch is a set of up to 20 samples of the same matrix processed using the sample procedures and reagents within the same time period. The Quality Control Batch must contain a Matrix Spike/Matrix Spike Duplicate (MS/MSD), a Laboratory Control Sample (LCS) and a Method Blank (MB). For Method 9056, or in some cases at client request, the MS/MSD may be replaced with a Matrix Spike and Sample Duplicate (MS/DU). Method 9056 also requires the analysis of a sample duplicate for one in every ten samples.

9.2.1. Batches for all water samples are defined at the analytical level and are specific to individual instruments. Refer to the QC Program document (PQA-003) for further details of the batch definition. Batches for all soil/solid samples are defined at the sample preparation stage. Prep batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the

same sequence. See SOP WS-WC-0049 for additional information on the soil/solid preparation procedure.

9.2.2. Standards/samples are evaluated separately for each individual anion. Example: If an LCS fails for one anion, all associated samples being analyzed for that particular anion are subject to corrective actions. All other anions can be reported with no corrective action, assuming that all other QC criteria has been met for the batch. See Table A for acceptance criteria and corrective actions.

9.2.3. Method Blanks (MB)-One method blank must be prepared with every process batch of similar matrix, not to exceed twenty samples. The method blank is carried through the entire analytical procedure and must have a concentration of less than the reporting limit for the analyte of interest, or less than ½ the reporting limit for projects covered by the DoD QSM.

9.2.3.1. ICB-analytical blank made of reagent water, analyzed after the ICV and evaluated as the MB.

9.2.3.2. CCB-analytical blank made of reagent water, analyzed after each CCV.

9.2.3.3. Soil/solid samples-a water blank taken through the preparation procedure is analyzed during the run in addition to the ICB/CCBs and evaluated as the MB.

9.2.4. Laboratory Control Sample (LCS)-An LCS must be analyzed with every process batch of similar matrix, not to exceed twenty samples. The LCS contains known levels of the analytes of interest.

9.2.4.1. ICV/REF/LCS-daily initial calibration verification from a second source analyzed to verify instrument calibration and evaluated as the LCS. Acceptance criteria: 90%-110%.

9.2.4.2. CCV-a midlevel standard, preferably the 3R calibration standard, analyzed after every ten samples and at the close of the analytical run. The concentration of the CCV standard shall be between the low calibration standard and the mid-point of the calibration range. For Method 300.0 compliance, each CCV must be within 90%-110% (± 10%) of the true value. If a CCV fails the criteria, all samples surrounding the failed CCV should be reanalyzed for the out of control anions. For Method 9056 compliance, in addition to evaluating the drift from the calibration (i.e., ±10% of the true value), evaluate the overall instrument drift. Each CCV must be within ± 5% of the response of the preceding CCV, in addition to ± 10% of the true value. If one of the criteria is not met for a

particular anion, all samples surrounding the failed CCV should be reanalyzed for the out of control anion. For more information, refer to WS-PQA-003.

9.2.4.3. The LCS for soil/solid samples is prepared from a water blank taken through the preparation procedure. The LCS is spiked after the prep and prior to the analysis. Acceptance criteria: 85%-115%.

9.2.5. Matrix Spikes (MS/MSD)-A Matrix Spike/Matrix Spike Duplicate pair must be analyzed with every process batch of similar matrix, not to exceed twenty samples. An MS/MSD pair are aliquots of a selected field sample spiked with analytes of known identity and concentration where the spike level should be at or near the concentration used for the LC, or the mid-point of the curve. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Acceptance criteria for aqueous samples is 90% - 110%. For solids and wipes the acceptance criteria is 85%-115%, 20% RPD.

9.2.5.1. Additionally the MS/MSD for soil/solid samples is prepared from a sample duplicate taken through the preparation procedure. The MS/MSD is spiked after the prep and prior to the analysis.

9.2.6. Laboratory Control Sample Duplicate (LCSD/LCSD)-A duplicate control sample may be substituted when insufficient sample volume is provided to process an MS/MSD pair as required by program or client. The LCSD is prepared, analyzed and evaluated in the same manner as the LCS.

9.2.6.1. An additional ICV/REF/LCS standard can be analyzed during the run, or two successive CCVs can be reported as the LCS and LCSD.

9.2.6.2. Soil/solid samples - an additional aliquot of the LCS water blank is taken, prepared and analyzed in the same manner as the LCS.

9.2.7. See Table A for acceptance criteria and corrective action.

10. CALIBRATION

10.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 “Calibration Curves (General)”.

10.2. Prepare standards containing each analyte of interest at a minimum of 4 calibration levels and a reagent blank. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Refer to 7.10 and 7.11 for standard levels and preparation.

10.3. Initial Calibration (Demonstration of Linear Calibration Range)

10.3.1. A new calibration curve must be generated monthly or sooner if:

Major changes are made to the system or when the daily continuing calibration verification (ICV/CCV) criteria cannot be met. Major changes include new columns, or any changes in instrument operating parameters, including eluent flows, eluent strength, eluent stock solutions, etc.

10.3.2. The initial calibration curve must be verified daily by the analysis of a mid-level continuing calibration standard (ICV).

10.3.3. Quantitation by the external standard method assumes a proportional relationship between the calibration run and the analyte in the sample. To use this approach introduce each calibration standard into the IC using the technique that will be used for samples. The ratio of the peak height or area response to the mass or concentration injected may be used to prepare a calibration curve.

10.3.4. The curve utilizes a linear regression with offset, set to include zero (0,0). Correlation coefficient of each analyte, r, must be > 0.995 for the initial calibration to be acceptable.

10.4. Retention Times

10.4.1. The instrument records retention times for each anion during the initial calibration.

10.4.2. Retention time of target analytes shift as a function of total anion concentration. Nitrate and sulfate exhibit the greatest retention shifts, although all anions are affected to some degree. In some cases, this peak migration may produce poor resolution or identification.

10.4.3. The width of the retention time window used to make identifications should be based on measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size for each analyte. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

10.4.3.1. Retention time window study shall be performed after major maintenance which affects the chromatography system (e.g. column change).

10.4.4. The approximate retention time and % window size is listed in Section 1.3, which is based on historical performance.

10.4.4.1. Criteria: The maximum allowable shift in the retention time/ instrument response is 10%.

10.4.4.2. Corrective Action: Repeat analysis using fresh calibration standards. If the results are still more than 10%, a new calibration curve must be prepared for that analyte.

10.5. Nonlinear response can result when the separator column capacity is exceeded (overloading). Maximum column loading (all anions) should not exceed about 400 ppm.

10.6. Initial and Continuing Calibration Verification (ICV/CCVs and ICB/CCBs):

10.6.1. ICV/REF - The daily calibration verification must be analyzed at the start of each run, and once every 24 hours thereafter if samples are being analyzed. If there is a break in the analytical sequence of greater than 12 hours, then a new ICV run must be analyzed before proceeding with the sequence. If more than 24 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with an ICV.

10.6.2. CCV - analyzed every 10 injections and at the end of the analytical sequence. Evaluated in the same manner as the ICV.

10.6.3. ICB/CCB - Reagent water that is immediately analyzed following the ICV/CCV analysis.

10.6.4. Details of ICV/ICB and CCV/CCB acceptance are detailed in Table A.

10.7. Examples of analytical sequences (including frequency of calibration standards) are detailed in Table B.

11. PROCEDURE

11.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

11.2. Any unauthorized deviation from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.3. This method is recommended for use only by or under the supervision of analysts experienced in the use of ion chromatography and in the interpretation of the resulting ion chromatograms.

11.4. Instrument start-up: The Ion Chromatography instrument and all of its components including the printer are routinely on and ready for operation. Though the system is on, the analyst has to initiate the following steps before the instrument is ready for analysis.

11.4.1. Ensure that the eluent is in sufficient supply for the entire run, and the waste carboy has plenty of capacity.

11.4.2. Through the Chromeleon software, access the control panel for the ICS-1000. Press the "start" button to initiate the instrument.

11.4.3. Make sure that the following instrument parameters are set:

- Pump Speed: 1.2 mL/min,
- Suppressor Current: 31 mA,
- Cell temperature: 30°C
- System Pressure: Pressure requirements vary for different columns. Follow the manufacturers recommended settings for each column..

11.4.4. Let the system equilibrate for 10 minutes. If the system pressure is fluctuating, follow the manufacture's instructions for priming the pump. If this does not solve the problem, check the system for leaks. If no leaks are present, the pump head seals may need to be replaced.

11.4.5. The instrument is now ready for use.

11.5. Preliminary Set-up:

11.5.1. Establish the baseline by injecting at least one vial with reagent water through the system until a stable baseline is obtained.

11.5.2. Inject the calibration curve. Concentrations of the curve should bracket the concentration range of the samples. Inject the lowest concentration first. Verify that the correlation coefficient is at least 0.995 for each anion of interest. Calibration is done monthly but is verified daily.

11.6. Sample Pre-treatment:

All samples and standards are filtered through a 0.2 micron filter that is part of the sample vial cap design prior to analysis. Samples that have particulates larger than 0.45 micron must be filtered before placing the aliquot in the sample vial. This will minimize pressure build up and dirt clogging the system.

Warning: Exercise caution when using syringes with attached filter assemblies. Application of excessive force has, upon occasion, caused a filter disk to rupture during the process.

11.7. Sample screening: The conductivity of the samples is measured and used as a tool to determine approximate dilution needed to keep the sample reading within calibration range. Additionally, test strips for Chloride may be used to estimate the concentrations of this analyte. Follow manufacturer instructions for use, and prepare sample dilutions accordingly. Listed are the recommended dilutions to make based on the measured conductivity (EC):

Measured Conductivity (EC) [f] (umhos/cm)	Suggested Dilution [g] (XX)
1 to 1,000	1X
1,000 to 5,000	5X
5,000 to 10,000	10X
10,000 to 20,000	20X

[f] Approximate measurements only.
[g] Varying dilutions may be necessary toward the end of the run to ensure that the sample reading is at least 3-5 times higher than the lowest standard. Historical dilution data supersedes this table.

11.8. For holding time purposes and to minimize sample handling, sequential multiple dilutions per sample are highly recommended.

11.9. Check the pH of samples that have a very high EC reading to ensure that the samples are not preserved.

11.10. Samples that are viscous, have dark color, foul odor or known to have high salt content must be diluted immediately regardless of the EC reading to prevent instrument damage.

11.11. Soil samples are prepared by leaching one part sample with five parts of reagent water. Refer to SOP No. WS-WC-0049.

11.12. Sample analysis:

11.12.1. Verify system calibration daily with an ICV and, if required, re-calibrate.

11.12.2. For analytical sequence set-up/schedule, see Table B.

11.12.3. Samples must be homogenized prior to filtering and aliquoting.

11.12.4. Pour approximately 5 mL of standard or well mixed sample or dilution thereof into the sample vial, and cap.

11.12.5. Arrange sample vials into the cartridge to reflect the analytical order in the bench sheet following the order in Table B. Enter all the information in the Dionex Chromeleon software schedule.

11.12.6. Set-up the analytical schedule following the steps below:

11.12.6.1. From the Chromeleon browser screen, copy the last schedule and save it as a new file, using the normal date format. If an old curve is to be used, copy in the raw data files for the standards.

11.12.6.2. Enter the following information: Sample Name (Lot ID, Standard ID, etc), Dilution Factor, Program (i.e. AS22A Anions), Method (AS22A Anions), and Weight (only needed for DI leachates or soil samples).

11.12.6.3. After the last CCB, under SAMPLE NAME, enter "SHUTDOWN"; under PROGRAM, enter "ICS 1000 SHUTDOWN. This will enable the instrument to automatically load the shutdown method at the end of the run, and all components of ICS 1000 will be turned off.

11.12.7. When the schedule is built and samples are loaded into the autosampler, press the "run" on the autosampler , then ress the "play" button. This will initiate the run.

11.12.8. The instrument is now in analysis mode. Each injection will take approximately 10 minutes.

11.13. Confirmation by Coinjection:

In the event that a positive is not absolutely identifiable due to retention time shifts, a coinjection may be made, as follows:

11.13.1. Determine the optimum sample concentration for analysis (within 1/2 of the linear range).

11.13.2. Prepare a dilution if necessary. Add sample and spikes and bring to a final volume of 5mL. Gently mix, then analyze. The MS/MSD spike levels may be used. The neat sample final volume will be 5mL plus the spike volume.

11.13.3. Presence of merged/shouldering peaks is indicative of matrix effects rather than a positive for that anion.

11.14. Instrument Shut-down

11.14.1. Automatic shut-down - At the end of the schedule list, enter the shutdown method as part of the schedule or,

11.14.2. Manually shut the instrument down by pressing the “stop” button on the ICS1000 control panel.

11.14.3. Sample vials and acidic waste generated after the analysis must be disposed of according to the waste streams detailed in Section 15.

12. CALCULATIONS/DATA REDUCTION

12.1. Anion Identification

12.1.1. Identification occurs when a peak matching the retention time of the reference standard is found at a concentration above the reporting limit, or above the MDL if J flags are required.

12.1.2. The experience of the analyst should weigh heavily in the interpretation of the chromatogram. For example, sample matrix or laboratory temperature fluctuation may result in a variation of retention times.

12.1.3. If manual integration is needed, refer to the Manual Integration Policy, QA-011-SAC. Save the file after manual integration.

12.1.4. The program Chromeleon marks a chromatogram that has been manually integrated by placing a [modified by *username*] above the chromatogram and an asterisk (*) next to the anion that was modified.

12.2. Confirmation

In some instances, a coinjection of standard solution and sample may be necessary to confirm the identity of a peak in the ion chromatogram. Details of preparing a coinjection analysis are discussed in Section 11.19

12.3. Calibration Range

12.3.1. If concentration of any analyte exceeds the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed for that analyte.

12.3.2. Responses for the diluted samples must be 3-5 times the level of the lowest standard.

12.3.3. It may be necessary to dilute samples due to matrix.

12.4. Calculations

All instrument concentrations are calculated using a linear regression with offset, set to include zero (0,0) calculation automatically performed by the instrument, according to the following equation:

Equation 1

Concentration (mg/L) $y=mx + b$

Where:

x and y are variables

b = intercept point of the regression line and the y axis

m = slope of the regression line

Equation 2

*Sample Concentration (mg/L) = Instrument Concentration (mg/L) * DF*

Where *DF* = Dilution Factor

Equation 3

*Sample Concentration (mg/kg) = Instrument Concentration (mg/L) * DF * V_l/ M_s*

Where *DF* = Dilution Factor

V_l = Volume of Leachate (in L)

M_s = Mass of Soil (in kg)

NOTE: For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to SOP CA-Q-S-005 "Calibration Curves (General)".

12.5. Reporting Requirements

12.5.1. Reporting limits and units are described in Section 1.3.

12.5.2. Sample results are entered into a LIMS system in accordance with current QA policies. When reporting calculated percentages for the purposes of quality control, round to two significant digits unless the value is over 100%. If the value is over 100%, round to three significant digits.

12.5.3. Footnotes and anomalies when applicable must be included in data entry and data reduction process. Exceeded holding times must be immediately communicated to project managers and followed by electronically filed HTV.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit: The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be established annually and verified via an

MDL check at 6 month intervals. See the MDL SOP WS-QA-0006 for details. The MDL must be below the reporting limit for each analyte.

13.3. Initial Demonstration: Each analyst must make a one time initial demonstration of capability for each individual method. This requires analysis of QC check samples containing all of the standard analytes for the method.

13.3.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid level calibration.

13.3.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.3.3. If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.4. Training Qualification: The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

13.5. This method is recommended for use only by analysts experienced in the use of ion chromatography and in the interpretation of the ion chromatograms.

14. POLLUTION PREVENTION

All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in Section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

15. WASTE MANAGEMENT

The following waste streams are produced when this method is carried out.

15.1. Alkaline, neutral and/or acidic eluent waste generated by the analysis. The waste from the instrument is collected in 2.5 liter plastic coated jugs. When full, transfer the jug to the main waste area for shipment.

15.2. Contaminated solid waste such as IC syringes, filters, caps and empty vials utilized for sample preparation. Dump the solid waste into a contaminated lab trash bucket. When the bucket is full or at the end of the day, whichever comes first, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the

drum is full or after no more than 75 days, move it to the waste collection area for shipment.

15.3. Unused sample material. Pour any excess liquid into a 1-liter to 4-liter HPLC collection carboy at the fume hood. When the carboy is full, or at the end of your shift, whichever comes first, empty the carboy into the plastic HPLC collection drum in the H3 closet. When the drum is full to between two and six inches of the top, or after no more than 75 days, move the drum to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. EPA Test Method 300.0 entitled, "The Determination of Inorganic Anions by Ion Chromatography" published in EPA-600/R-93/100, Revision 2.1, August 1993.

16.2. SW-846 update III, Method 9056, Revision 0, September 1994

16.3. List of other SOPs cross-referenced in SOP.

16.3.1. QA Policy WS-PQA-003, Quality Control Program.

16.3.2. WS-QA-0006, Method Detection Limits and Instrument Detection Limits.

16.3.3. WS-WC-0049, Deionized Leaching Procedure For General Chemistry Analyses.

17. METHOD MODIFICATIONS

17.1. Deviations from reference method rationale:

17.1.1. This SOP covers anions listed on Part A of Method 300.0. This facility does not have the capability to perform analytes listed in Part B.

17.1.2. Eluent strength: The eluent strength used for this SOP has been changed from what is recommended in EPA Method 300.0 and SW-846 Method 9056, respectively. The strength is changed to enhance peak area and height characteristic, baseline resolution and improve ion separation between analytes based on manufacturer's recommendation for the AS22A column.

17.1.3. Drying of Neat Materials: Section 7.5 of Method 300.0 is adopted with regards to drying of neat materials at 105 °C for at least 30 minutes instead of drying them at varying temperatures as Method 9056 recommends.

17.1.4. Neat Material Substitution: Section 7.5 of Method 300.0 and Section 5.5 of Method 9056 recommend using the following salts for stock standard solutions: NaBr, NaCl, and $NaNO_3$. This laboratory has substituted KBr,

KCl, and KNO_3, respectively.

17.1.5. Stability of Standard Extended: Section 7.5 of Method 300.0 and Section 5.5 of Method 9056 both comment that stock standard solutions are valid for a period of one month if stored at 4°C, and that working solutions are valid for a period of one week (one day for nitrite and phosphate stocks). This laboratory maintains that stock standard solutions are valid for a period of one year when stored at 4°C, that Nitrite, Nitrate, and Ortho-phosphate solutions are stable for up to 6 months, and that all working standards are valid for a period of one month. The change of expiration dates are based on a stability study performed by the laboratory for these analyses.

17.1.6. Calibration utilizes linear regression with offset, set to include zero (0,0). This SOP calculates the concentration from the peak area using linear regression.

17.1.7. The columns specified in the reference method have been replaced with alternatives. This change was motivated by advances in technology which occurred after publication of the method. Likewise, the use of suppressor regenerant solution has been discontinued.

17.1.8. Nitrate + Nitrite determinations on preserved samples cannot be done by this method due to severe interferences introduced by the preservative. Samples for this determination are usually preserved with H_2SO_4 and should be analyzed by a different method such as the Cd-reduction/colorimetric method.

17.1.9. Preparation of diluted samples and standards using eluent as described in Section 7.2.1 of Method 9056 is not adopted here. For matrix matching purposes, all standard preparations and sample dilutions are made with reagent water so as not to bias the undiluted samples.

17.1.10. Section 10.4 of Method 300.0 recommends that the calibration be verified every 20 samples. This SOP requires that the calibration be verified every 10 injections.

17.1.11. Section 8.2 of Method 9056 specifies “After every 10 injections, analyze a mid-range calibration standard. If the instrument response has changed by more than 5%, recalibrate.” This SOP incorporates this requirement in addition to the Method 300.0 ± 10% requirement when evaluating CCV standards.

17.1.12. Prep Factor for soil leaching procedure is changed from 10X (Section 11.7/Method 300.0) to 5X in order to meet lower reporting limits. The soil and water are mixed for 1 hour instead of 10 minutes, then centrifuged, decanted, and filtered.

17.1.13. LCS acceptance criteria for prep batch is 85-115 %, while the direct analysis batch is 90-110%. There is no guidance in either source method in regards to the LCS that is batched and prepared with soil/solid samples.

17.1.14. Section 9.3.1 of Method 300.0 criteria for Laboratory Reagent Blank (LRB) is below the MDL. Our criteria for Method Blank (MB) or LRB is below the reporting limit (RL), refer to QA PolicyWS-PQA-003.

17.1.15. Section 9.2.2 of Method 300.0 recommends that the Linear Calibration Range (LCR) must be determined initially and verified every 6 months or whenever a significant change in the instrument response (10% from Section 10.4) is observed or expected. This laboratory verifies the calibration with an ICV and reference standard prior to analysis, and mandates a new calibration monthly, or when eluent strength or eluent stock solutions are changed.

17.1.16. Section 7.3.4 of Method 300.0 - Calculation is done by linear regression with offset, set to include zero (0,0). The instrument automatically calculates concentration of the samples and is verified at the data reduction stage.

17.1.17. Section 8.3, 8.4/Method 9056 - Analyze one duplicate (DU) per 10 sample, one matrix spike (MS) every 20 samples. The laboratory adopted an MS/SD pair every 20 samples or less. Refer to WS-PQA-003, Quality Control Program.

17.1.18. Method 300.0 directs that MDLs should be performed semi-annually. TestAmerica West Sacramento's policy is to perform MDLs annually, with semi-annual verification.

18. ATTACHMENTS

18.1. Tables or figures referenced in body of SOP.

18.2. Table A - Quality Control and Calibration Criteria

18.3. Table B - Analytical Sequence (an example)

18.4. Table C - Instrument Operating Conditions

19. REVISION HISTORY

19.1. WS-WC-0009, Revision 3, Effective 04/13/2012.

19.1.1. Clarification of ASTM Type II water.

19.1.2. Revision of calibration types.

19.1.3. Editorial revisions.

19.2. WS-WC-0009, Revision 2.6, Effective 02/17/2011.

19.2.1. Section 1.3: Updated RT's and window sizes for anions.

19.2.2. Section 6: Updated P/N's for guard columns and Anion Self Regenerating Suppressor.

19.2.3. Section 7.3: Updated eluent concentrations.

19.2.4. Updated Table C for new instrument parameters.

19.2.5. Section 10.3.3: Changed from weighted quadratic equation to weighted linear equation.

19.2.6. Section 12.4: Change from quadratic to linear equation.

19.2.7. Section 19.6.7: Changed from: "Linear ranges and detection limits are different from the method source and are based on instrument performance and historical limits." to "Calculation is done by linear regression using peak area. This SOP calculates the concentration from the peak area using linear regression."

19.3. WS-WC-0009, Revision 2.5, Effective 06/04/2010.

19.3.1. Section 4.9 added – "Nitrite may be oxidized to form nitrate by bacteria in water solutions. It is recommended that standard solutions of nitrite and nitrate be stored separately until just prior to analysis."

19.3.2. Modified Section 7.10.4: "10.0 mL of AccuStandard custom mixed IC standard (IS-14936) to a final volume of 250 mL of reagent water. Add 0.02 mL of Nitrite (as N) stock standard to 5 mL of standard 3R just prior to loading on the instrument. This also applies to the CCV."

19.3.3. Modified Section 9.2.5, "Acceptance criteria for aqueous samples is 90% - 110%. For solids and wipes the acceptance criteria is 85%-115%, 20% RPD.

19.4. WS-WC-0009, Revision 2.4, Effective 03/09 /2010.

19.4.1. Section 7.8: added "…Working standards are to be stored at 4 ± 2°C."

19.4.2. Inserted Section 12.1.4: The program Chromeleon marks a chromatogram that has been manually integrated by placing a [modified by *username*] above the chromatogram and an asterisk (*) next to the anion that was modified.

Table A			
Acceptance Criteria and Corrective Actions-Anions			
QC Type	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Initial Calibration Curve	Calibrated initially, then monthly. Verified daily prior to analysis.	r > 0.995	Reanalyze once. If the problem persists, reprepare the standards, and recalibrate.
ICV/REF/LCS (Second Source Standard)	At start of every analytical sequence, following the initial calibration.	90%-110% Recovery	Reanalyze once. If the problem persists, reprepare the standards, reanalyze, and/or recalibrate.
ICB/CCB/MB	Directly following ICV/CCVs.	<Reporting Limit <½ RL for DoD QSM	Reanalyze once. If the problem persists, isolate the source of the problem and fix it. If the problem is isolated to the blank, reprepare, reanalyze and proceed. If the problem may have affected previous sample results (i.e. instrument failure, contaminated test tubes, etc.), reanalyze samples bracketed by the failed blank.
CCV	After every 10 samples and at the end of the analytical sequence.	90%-110% Recovery Method 9056: ± 5% RPD for adjacent CCV	Reanalyze once. If the problem persists, isolate the source of the problem and fix it. If the problem is isolated to the standard (i.e. misspike, scratched test tube, etc.), reprepare, reanalyze and proceed. If the problem may have affected previous sample results (i.e. instrument failure, contaminated test tubes, etc.), reanalyze samples bracketed by the failed standard.
MS/SD	1 MS/MSD pair per batch of 20 samples or fewer.	90%-110% Recovery, aqueous 80%-120% Recovery, Solids and wipes 20%RPD	Reanalyze once. If reanalysis recovery fails but % RPD passes, accept data. If reanalysis passes, report reanalysis.
MB-solid (ICB=MB for aqueous)	1 per batch of 20 samples or fewer	< Reporting limit <½ RL for DoD QSM	Reanalyze once. If problem persists, reprepare and reanalyze batch.
LCS - solid (ICV=LCS for aqueous)	1 per batch of 20 samples or fewer	85%-115%	Respike aliquot and reanalyze. If problem persists, reprepare and reanalyze batch.

Table B		
Analytical Sample Sequence (An example)		
Injection Number(s)	**Sample ID**	**Comments**
1	Reagent Blanks (Can be done manually and separately from the run.	Establish stable baseline.
2,3,4,5,6	Initial Calibration (Monthly, or when needed)	Least Concentrated to Most Concentrated Standard. (Not always needed, see text).
7	Initial Calibration Verification (ICV)	Report as LCS for non-prep samples
8	Initial Calibration Blank (ICB)	Report as MB. Reagent water
9-18	Samples (including MS/SD if requested and prep MB/LCS and associated samples, MS/SD).	10 injections between ICV/ICB and CCV/CCB or CCV/CCB pairs..
19	Continuing Calibration Verification (CCV)	If LCS Dup. required, successive CCV's and be reported as LCS and LCSD for non-prep samples.
20	Continuing Calibration Blank (CCB)	Use Level 0 Standard Solution. (Reagent water)
Repeat injections 9 through 20 until all samples are injected	10 injections followed by CCV/CCB.	Ending CCV/CCB closes the run
Last entry of the RUN	Enter as SHUTDOWN file in IC-51000 Program. SHUTDWN1 Program.pgm.	The instrument will automatically shut-off if the "shutdown method" is included in the scheduled run log.

Table C	
Instrument Operating Conditions, "IC6" Parameter under AS22 MethodHigh	
Parameter Name	**Parameter Value**
Minimum Area	**0.005**
Sensitivity	**0.0001**
Peak Slice	**10.00 s**
Fronting Sensitivity Factor	**2.5**
Tailing Sensitivity Factor	**5.5**
Minimum Width	**0.10 min**
Valley to Valley	**On**

Title: Determination of Alkalinity, Conductivity, and pH [Methods: SM 4500 H^+-B, SM 2320B, EPA 9040B, EPA 9040C w/ Update IV, EPA 120.1]

Approvals (Signature/Date):

Elizabeth Nguyen Technical Manager — 7/17/12 Date	Joe Schairer Health & Safety Manager / Coordinator — 9/4/12 Date
Douglas Weir Quality Assurance Manager — 08/30/12 Date	Karla Buechler Laboratory Director — 9/6/12 Date

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1. SCOPE AND APPLICATION

1.1. This procedure defines the automated analysis of alkalinity (SM 2320B), pH (SM 4500 H^+-B and 9040B), and conductivity (EPA Method 120.1). The instrument used for analysis is a Man-Tech PC-Titration Plus system equipped with PC-Titrate software and a standard PC-Titrate XYZ autosampler. The different forms of alkalinity (total, bicarbonate, carbonate, and hydroxide) can be calculated.

1.2. The detection limits are:

pH --Detection limit not applicable
Specific conductance – 2 µmhos/cm
Alkalinity – 5 mg/L as calcium carbonate (25 mg/kg for solids)

1.3. This method is applicable to drinking, surface and saline waters, domestic and industrial wastes. Solid samples require a leaching process prior to analysis (see SOP WS-WC-0049). Soil samples for pH by method 9045D w/ Update IV are analyzed according to SOP WS-WC-0044.

1.4. This method is applicable to all ranges likely to be encountered. As a practical matter, samples with alkalinities greater than 1500 mg/L as calcium carbonate should be analyzed using a stronger titrant. For lower detection limits, analyze the sample using 0.02N H_2SO_4 acid as the titrant.

2. SUMMARY OF METHOD

2.1. Samples are analyzed on an automatic titrator. The instrument is capable of analyzing any or all of the components defined in Section 1.1 during a single analytical run.

2.2. Specific conductance is measured by application of a voltage across the conductivity cell in series with a known reference resistance. The ratio of voltage across the cell and the known resistance is measured which allows the resistance of the cell to be calculated. This is then converted to the conductance of the cell. By calibrating against a solution of known conductance, the cell constant is determined and also the specific conductance of the sample in the cell. A thermocouple measures the temperature of the sample and electronically corrects the measurements to 25°C.

2.3. The pH is determined electrometrically with a glass electrode in combination with a reference electrode. The special glass used in the electrode develops a voltage across it that depends on the pH of the solution being analyzed. The voltage is measured and converted to pH by calibration against buffers of known pH.

2.4. Alkalinity is determined by titrating the sample with a standardized acid to specified endpoints (pH 8.3 and 4.5). Alkalinity is calculated from the volume of acid required to reach the endpoints and is traditionally reported as mg/L calcium carbonate.

3. DEFINITIONS

3.1. Definitions of terms used in this SOP may be found in the glossary of the Quality Assurance Manual (QAM).

3.2. Data qualifiers are defined on each data report. Commonly used data qualifiers are defined in the QAM.

4. INTERFERENCES

4.1. pH Interferences

4.1.1. The pH response of most glass electrodes is imperfect at both ends of the scale. The indicated pH value of highly alkaline solutions, as measured with the glass electrode, will be too low. The indicated pH value of salts and strong acids having a pH less than 1 will often be higher than the true pH value. Interferences can be minimized by the selection of the proper electrodes for these conditions. For example, sodium may interfere at pH > 10, and is controlled by using a "low sodium error" electrode.

4.1.2. The glass electrode, in general is not subject to solution interference from color, turbidity, colloidal material, oxidants, reductants, or high salinity.

4.1.3. Coatings of oily material or particulate matter can impair electrode response. These coatings can generally be removed with gentle wiping or washing with a mild detergent.

4.1.4. Temperature variations will change the pH of the samples and also affect electrode response. Electronic temperature correction must be used to correct for electrode response.

4.2. Alkalinity Interference

4.2.1. Salts of weak organic and inorganic acids will contribute to alkalinity. If the alkalinity is intended to be a measure of carbonate and bicarbonate only, the presence of these substances will cause high results.

4.2.2. See Section 4.1.3 for the effect of oily material on the pH electrode.

4.2.3. Particulates in the sample may affect the alkalinity results.

5. SAFETY

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), the West Sacramento Addendum to the Corporate EH&S Manual (WS-PEHS-002) and this document. This procedure may involve hazardous material,

operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toed, nonabsorbent shoes are a minimum.

5.1. Specific Safety Concerns or Requirements

5.1.1. Eye protection that satisfies ANSI Z87.1, laboratory coat, and chemically resistant gloves must be worn while samples, standards, solvents, and reagents are being handled. Latex, nitrile and vinyl gloves provide adequate protection against chemicals and reagents typically used with this procedure

5.1.2. Exposure to chemicals must be maintained **as low as reasonably achievable**; therefore all samples must be opened, transferred and prepared in a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.1.3. Laboratory procedures such as repetitive use of pipettes, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.2. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials Section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Acetic Acid (1)	Corrosive Poison Flammable	10 ppm-TWA	Contact with concentrated solution may cause serious damage to the skin and eyes. Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur.

Sodium Hydroxide	Corrosive	2 mg/m^3-Ceiling	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydradator	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
Total Ionic Strength Buffer (Acetic acid content)	Corrosive Poison Flammable	10 ppm-TWA	Contact with concentrated solution may cause serious damage to the skin and eyes. Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. The Man-Tech PC Titration Plus system consists of six major components. An autosampler, a Burivar I/2 burette for accurate delivery of titrant, a TitraSip module for titration, PC-Tis interface to the PC, a conductivity meter, and the titration/reaction vessel with stirring mechanism.

6.1.1. There are two electrodes used by the instrument. A conductivity electrode is mounted on the robotic arm of the autosampler to measure the conductivity in the autosampler tube. A pH electrode is installed into a titration vessel where the sample to be analyzed is transferred via the TitraSip module. The addition of reagents, and analyses of pH, and alkalinity take place within the titration vessel.

6.2. Conductivity electrode.

6.3. Model 4310 conductivity meter with auto range from 0.01 umhos/cm to 199.9 mmhos/cm.

6.4. 50 mL polypropylene tubes.

6.5. Miscellaneous laboratory apparatus and glassware.

7. REAGENTS AND STANDARDS

7.1. Reagent water is produced by a Millipore Nanopure system. Water shall not contain particles larger than 0.20 micron and have a resistance of at least 18 Mohms. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks, in accordance with SOP WS-QA-0014, "Monitoring of Reagent-Grade Laboratory Water.

7.2. pH Reagents and chemicals

7.2.1. Certified buffer solutions: 2.0, 4.0, 7.0, 10.0 and 12.0.

7.2.2. Alternate source as an ICV or reference check. This must be obtained from a separate vendor.

7.2.3. 3N KCl pH probe reference solution.

7.3. Alkalinity Reagents and chemicals

7.3.1. Certified Stock Standards: ICV and CCV solutions are procured as QC solutions from separate vendors. The true values change as different mixed certified stocks are received.

7.3.2. 0.02N Certified sulfuric acid solution: obtained with certificate of analysis from a defined vendor.

Note: Alkalinity measurements that exceed 1500 mg$CaCO_3$/L require analysis using a 0.1N certified stock sulfuric acid solution.

7.3.3. pH buffer solutions: 2.0, 4.0, 7.0, 10.0 and 12.0.

7.4. Conductivity Reagents and Chemicals

7.4.1. Certified conductivity standards are used to calibrate the meter. In most cases, the standards are 1413 umhos/cm at 25ºC. Fresh aliquots of the standard must be used for calibration.

7.4.2. Certified conductivity standards of varying concentration are obtained from separate vendors for use in ICV/CCV analysis. Fresh aliquots of the standard must be used for analysis.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Samples are to be collected in plastic bottles and refrigerated to 4°C.

8.2. Samples for alkalinity must not be filtered, diluted, concentrated, or altered in any way.

8.3. Upon arrival to the laboratory, pH samples must be directly delivered to an analyst in the general chemistry area for immediate analysis. The official holding times for these parameters are: pH – 15 minutes; Conductance – 28 days; Alkalinity – 14 days.

9. QUALITY CONTROL

9.1. Batch - A quality control batch is a set of no more than 20 field samples that consist of the same matrix and are processed using the same procedures, reagents and standards. A batch must be analyzed within the same time frame. A method blank (MB) and laboratory control sample (LCS) are analyzed as a part of every batch. Each batch must also be processed with a matrix spike/matrix spike duplicate (MS/MSD), or in some instances a sample/sample duplicate. An analysis batch must include all QC samples, however they do not contribute to the maximum of 20 samples (see policy WS-PQA-003 (Quality Control Program) for more details).

9.2. One method blank must be reported for every 20 samples, with the exception of pH, which has no method blank analysis. For the first 20 samples (batch), the initial calibration blank (ICB) is reported as the method blank. If a method blank exceeds ± the reporting limit than the samples must be re-extracted. The exception is samples that are less than the reporting limit and those that exceed 10X the concentration of the analyte in the method blank. In such cases, the data can be reported and all corrective actions documented on a Non-Conformance memo. See policy WS-PQA-003 (Quality Control Program) for more details.

9.3. If more than 20 samples are analyzed, the continuing calibration blank (CCB) immediately preceding analysis of the second batch is reported as the method blank for all samples associated with the batch. If a method blank exceeds +/- the reporting limit, the analysis must be stopped, the problem resolved, and the samples bracketed by the out of control method blank must be re-analyzed. The 20 sample criteria excludes MS/MSD and sample duplicate analyses (see policy WS-PQA-003 (Quality Control Program) for further details).

9.4. A laboratory control sample (LCS) must be reported for every 20 samples analyzed. For the first 20 samples (batch), the ICV is reported as the LCS. If more than 20 samples are analyzed, the CCV immediately preceding analysis of the second batch of samples is reported as the LCS for the associated samples. If a LCSD (LCS/LCSD) is required, an additional aliquot of the ICV solution is analyzed as the LCSD, , alternatively, the first two CCVS are reported as the LCS/LCSD. If more than 20 samples are analyzed, the CCV immediately preceding analysis of the second batch of

samples is reported as the LCS for the associated samples and the next additional CCV is reported as the LCSD. As with ICV/CCVs, the LCS acceptance criterion is 90-110% recovery with the exception of pH. The pH reading must be within 0.1 pH units of the true value.

9.5. For alkalinity, pH, and conductivity, a sample and sample duplicate are analyzed in place of an MS/MSD pair in association with every batch. A sample/ sample duplicate are replicate samples set up in separate autosampler tubes and analyzed within a single analytical run. The relative percent difference (RPD) between the sample and the sample duplicate must be within 20%. For pH, the measurement between the sample and sample duplicate cannot exceed 0.1 pH units. For the tests defined in this SOP, careful evaluation of sample/sample duplicate results must be considered when differences are significant since these tests exhibit good accuracy.

9.6. Samples identified as field blanks, equipment blanks, or trip blanks should not be used for sample/sample duplicate analysis.

9.7. A laboratory control sample duplicate (LCS/LCSD) may be substituted when insufficient volume is provided to process a sample/sample duplicate or MS/MSD pair if required by client or program. The LCS and LCSD are evaluated independently for acceptance (see policy WS-PQA-003 (Quality Control Program) for further details.

9.8. Initial Calibration Verification (ICV/ICB) – Calibration accuracy is verified by analyzing a second source standard. This standard must be at a concentration different from those used to calibrate the instrument and different from the CCV standard. The ICV must fall within +/- 10% of the true value of the standard solution. For pH the value must be +/- 0.1 pH units. An ICB prepared the same as the calibration blank, or from nanopure water, must be analyzed immediately following the ICV to monitor low level accuracy and system cleanliness. The ICB result must fall within +/- the reporting limit from zero. If either the ICV or ICB fail to meet acceptance criteria, the analysis must be terminated, the problem corrected, and the instrument re-calibrated.

Note: pH has no ICB or CCB analysis.

9.9. Continuing Calibration Verification (CCV/CCB) – Calibration accuracy is analyzed throughout the analytical run by analyzing a continuing calibration standard (CCV) of a known concentration every 10 samples. In this case a sample is any analysis that registers a result, whether the result is reported or not. The CCV must be a mid-range standard at a concentration other than that of the ICV. In most cases the CCV is one of the middle standards used during calibration. The CCV must fall within +/- 10% of the true value. For pH the value must be +/- 0.1 pH units. A continuing calibration blank (CCB) prepared the same as the calibration standard must be analyzed following every CCV. The CCB must fall within +/- RL from zero. Each CCV and CCB analyzed must reflect the conditions of the analysis of the associated samples. Do not run rinses or increase rinse times prior to CCVs unless you do so between every sample. Sample

results may only be reported when bracketed by valid ICV/ICB and or CCV/CCB pairs as applicable. If a CCV or CCB fails, the analysis must be terminated, the problem corrected, the instrument re-calibrated, the calibration verified and the affected samples reanalyzed.

10. CALIBRATION

10.1. Calibration of the instrument must be performed every 24 hours of operation.

10.2. Calibrate according to the instrument manufacturer's instructions. Analyze standards in ascending order.

NOTE: Refer to the following sections in the instrument manufacturers handbook for additional information. Section 13.10.5 (pH and alkalinity), and Section 13.12.5 (conductivity).

10.3. The calibration curve must have a correlation coefficient of > 0.995 for pH, or the instrument must be stopped and re-calibrated prior to running samples.

10.4. The accuracy of the calibration is verified using a secondary source (ICV). See Section 9.8 for more details.

10.5. The instrument must be calibrated at a minimum of two points that bracket the expected pH of the samples and are approximately three pH units or more apart.

11. PROCEDURE

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file. Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Obtain samples from sample receiving. Check each sample for special instructions. Thoroughly homogenize samples before taking an aliquot for analysis. Allow aliquots to equilibrate to room temperature before analyzing.

11.3. Pre-run Checklist

11.3.1. Assure the nanopure water reservoir is full.

11.3.2. For alkalinity, assure the storage bottle contains enough 0.02 N H_2SO_4 to complete the analysis.

11.3.3. For alkalinity assure that no gas bubbles are present in the I/2 Burette module. If gas has accumulated in the burette, go to the maintenance Section of the operations manual for the degassing procedure.

11.3.4. Assure that the pH electrode is filled with the appropriate electrolyte solution.

11.3.5. Assure that the waste carboy has adequate space for the run to complete without overfilling.

11.4. Starting the analysis

11.4.1. Templates are pre-programmed into the instrument for various combinations of analyses. Each template contains all of the parameters required to operate the system for analysis of the chosen analytes.

11.4.2. The template contains the run sequences with pre-programmed calibration commands and instrument QC locations.

11.4.3. Program sample IDs into autosampler positions in the template and save the file.

11.4.4. Place calibration solutions, instrument QC and samples into the appropriate positions and start the analysis.

11.4.5. For conductivity, the meter has to be calibrated prior to initiation of the analysis.

11.4.6. At the end of any run sequence, a storage solution has to be poured into the position following the last analysis. The instrument automatically goes to this position to fill the reservoir during periods of non-operation.

11.5. pH analysis

11.5.1. Quantitative results can only be reported between 2 and 12 pH units per the calibration range.

11.5.2. Make sure the pH probe is filled with 3N KCl solution. The refill procedure is described in the PC-Titrate Hardware Guide.

11.5.3. For pH, the sample is transferred from a sipper, through the TitraSip module to the titration vessel.

11.5.4. Set up the complete run sequence for the buffer solutions and samples to be

analyzed.

11.5.5. Pour approximately 40-45 mL of calibration buffer and samples into sample tubes and calibrate the instrument using pH buffers 2, 4, 7, 10, and 12.

11.5.6. Begin the analysis with an ICV. There is no ICB analysis for pH.

11.5.7. The vessel is automatically rinsed with DI water between each analysis.

11.6. Alkalinity analysis

11.6.1. An unaltered sample is titrated to an end point of pH 4.5. The sample must not be filtered, diluted, concentrated or altered in any way.

11.6.2. The total alkalinity measurement can be broken down to the measurement of carbonate, bicarbonate, and hydroxide alkalinity.

11.6.3. Set up and calibrate the instrument for pH according to steps in Section 11.6.5.

11.6.4. For alkalinity, the sample is transferred from a sipper, through the TitraSip module to the titration vessel.

11.6.5. 0.02N sulfuric acid is added via the Burivar I/2 burette until the solution reaches a pH of 4.5. The precision of the burette is +/-0.2%.

11.6.6. Begin the analysis with an ICV/ICB.

11.6.7. For solid samples, a 10 mL aliquot of the DI leach is used for analysis.

Note: Alkalinity measurements that exceed 1500 mg $CaCO_3$/L require analysis using 0.1N certified stock sulfuric acid solution

11.7. Conductivity Analysis

11.7.1. Samples are measured by a conductivity probe attached directly to the robotic arm of the autosampler and the conductivity is measured in the 50 mL sample tubes.

11.7.2. Results are automatically corrected to 25ºC with a predefined temperature coefficient of 1.91%.

11.7.3. The electrode is fragile and must be handled carefully. The electrode should be stored submersed in water.

11.7.4. The reporting limit for conductivity is 2.0 umhos/cm (2.0 uS/cm).

11.7.5. Calibrate the conductivity meter using a single certified standard programmed into the conductivity meter. The autosampler is not used to calibrate the conductivity meter.

11.7.6. Pouring 40-45 mL of sample into each tube, load the autosampler and begin analysis, starting with an ICV/ICB pair.

11.8. No specific conversion is needed for this instrument. The conductivity meter automatically carries out temperature compensation. The reference temperature is preset at 25ºC and the temperature coefficient is set at 1.91%.

12. CALCULATIONS/DATA REDUCTION

12.1. Alkalinity Calculation (performed by software)

12.1.1. Alkalinity of samples:

(Normality of acid) x (mL of acid) x 50,000 / Sample volume (mL)

12.1.2. Alkalinity of low samples (<20 ppm):

[(2A – B) x Normality of acid x 50,000 / Sample volume (mL)

A = ml of acid to pH 4.5 B = mL of acid to pH 4.2

12.1.3. Alkalinity in Solids

$$Alkalinity\ in\ solids(mg/g) = Alkalinity(mg/L)x\frac{FV(mL)}{IW(g)}$$

FV = Final Volume
IW= Initial Weight

12.1.4. Alkalinity equilibrium between the components of the alkalinity buffer system are calculated by the instrument software according to the following:

Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Alkalinity
P = ND	ND	ND	T
P < T/2	ND	2P	T - 2P
P = T/2	ND	2P	ND
P > T/2	2P - T	2(T - P)	ND
P = T	T	ND	ND

Where:

T = Total Alkalinity = Alkalinity at pH 4.5

P = Phenolphthalein Alkalinity = Alkalinity at pH 8.3

12.1.5. Default sample volume for aqueous analysis is 20 mL. Default sample volume for solid analysis is 10 mL, taken from DI leachate.

13. METHOD PERFORMANCE

13.1. The group/team leader has the responsibility to ensure that an associate who has been properly trained in its use and has the required expertise performs this procedure.

13.2. Both prep and analytical chemists must pass the initial demonstration of capability (IDOC), as outlined by this facility.

14. POLLUTION CONTROL

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

15. WASTE MANAGEMENT

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to SOP WS-EHS-0001. The following waste streams are produced when this method is carried out.

15.1. Aqueous alkaline or acidic waste generated by the analysis. This is collected in a 5-gallon plastic carboy. When the carboy is full, or after no more than one year, the pH should be checked. If not neutral or slightly alkaline, add a small amount of sodium bicarbonate to the waste to neutralize it at the fume hood. Then move the carboy to the waste collection area where it will be consolidated into a plastic LLE drum for shipment.

15.2. Contaminated disposable glass and/or plastic materials used in the analysis. Dump the solid waste into a contaminated lab trash bucket. When the bucket is full, tie the plastic bag liner shut and put the lab trash into the steel collection drum in the H3 closet. When the drum is full or after no more than 75 days, move it to the waste collection area for shipment.

16. REFERENCES/CROSS REFERENCES

16.1. Methods for Chemical Analysis of Water and Wastes, Method 150.1, pH Method 150.1 (Electrometric), (Revised 1982).

16.2. Methods for Chemical Analysis of Water and Wastes, Method 120.1, Conductance, Method 120.1 (Specific Conductance, µmhos at 25˚C), (Revised 1982).

16.3. Methods for Chemical Analysis of Water and Wastes", Method 310.1, Alkalinity Method 310.1 (Titrimetric, pH 4.5), (Revised 1978).

16.4. Standard Methods for the Examination of Water and Wastewater, Method 2320B (Alkalinity, Titration Method), 18th Edition, 1992.

16.5. Standard Methods for the Examination of Water and Wastewater, Method 2320B (Alkalinity, Titration Method), 19th Edition, 1995.

16.6. Method 2320B, Alkalinity – Titration Method, "Standard Methods for the Examination of Water and Wastewater," 20th Edition, 1998.

16.7. Standard Methods for the Examination of Water and Wastewater, Method 2510B (Conductivity, Laboratory Method), 18th Edition, 1992.

16.8. Standard Methods for the Examination of Water and Wastewater, Method 2510B (Conductivity, Laboratory Method), 19th Edition, 1995.

16.9. Method 2510B, Conductivity, "Standard Methods for the Examination of Water and Wastewater," 20th Edition, 1998.

16.10. SW-846 Update III, Method 9040B Rev.2, Jan. 1995.

16.11. Method 4500-H+, pH Value, "Standard Methods for the Examination of Water and Wastewater," 20th Edition, 1998.

16.12. Method 9050A, "Specific Conductance", Test Methods for Evaluating Solid Waste, EPA SW-846 Third Edition, 12/96.

17. METHOD MODIFICATIONS

17.1. Deviations from Source Methods and Rationale

17.1.1. Temperature is not reported with the pH measurement. All measurements are made at room temperature (approximately 22°C). The instrument performs automatic temperature compensation.

17.1.2. pH is analyzed as a single analysis.

17.1.3. The instrument guidelines specify switching to 0.1N sulfuric acid for titration at >1500 mg $CaCO_3$/L

17.1.4. The conductivity cell constant is calculated automatically by the equipment,

and is not calculated manually by the analyst.

17.1.5. All standards and reagents used for these methods are purchased as certified stock solutions. .

18. ATTACHMENTS

None

19. REVISION HISTORY

19.1. WS-WC-0028, Revision 4.3, Effective 07/20/2012

19.1.1. Section 9.4: Clarified LCS/LCSD requirements.

19.1.2. Inserted Section 10.5: Bracketing of samples with pH calibration points.

19.1.3. Editorial revisions.

19.2. WS-WC-0028, Revision 4.2, Effective 04/15/2011

19.2.1. Added requirement that fresh aliquots of standard be used for instrument calibration in sections 7.41 and 7.42.

19.2.2. Removed all Sections referring to fluoride analysis as the method is not supported by the laboratory.

19.2.3. Editorial corrections.

19.3. WS-WC-0028, Revision 4.1, Effective 03/05/2010

19.3.1. Inserted Section 7.1: Reagent water is produced by a Millipore Nanopure system. Water shall not contain particles larger than 0.20 micron and have a resistance of at least 18 Mohms. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks, in accordance with SOP WS-QA-0014, “Monitoring of Reagent-Grade Laboratory Water.

19.3.2. Section 10.2 NOTE: Inserted NOTE: Refer to the following sections in the instrument manufacturer’s handbook for additional information. Sections 13.10.5 (pH and alkalinity), 13.12.5 (conductivity), and 13.14.5 (fluoride).

19.4. WS-WC-0028, Revision 4, Effective 1/30/2009

19.4.1. Updated to TestAmerica format.

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Title: Carbon in Water (TOC, TIC, DOC, and TC)

[SM 5310B, SW 9060, SW 9060A]

Approvals (Signature/Date):

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1.0 Scope and Application

1.1 This standard operating procedure (SOP) provides instructions for determining the concentration of organic, inorganic, and total carbon in water samples by Standard Methods 5310B and SW-846 Methods 9060 and 9060A.

1.2 The working range is 1.0 to 50.0 mg/L for TOC/DOC and 1.0 to 40.0 mg/L for TIC. The range can be extended by sample dilution.

2.0 Summary of Method

2.1 This method uses a carbonaceous analyzer, which is capable of measuring total carbon (TC), inorganic carbon (IC), and total organic carbon (TOC) in water using oxidative combustion-infrared analysis. The manner of preliminary treatment, as well as the instrument settings, determines which forms of carbon are actually measured.

2.2 Approximately 20 mL of sample is acidified to convert inorganic carbon to carbon dioxide, which is then removed by sparging with air or nitrogen.

2.3 The organic carbon in the sample is oxidized by catalytic combustion to carbon dioxide. The carbon dioxide produced is measured by the infrared detector.

2.4 For the determination of total carbon, the initial acidification and sparging of the sample are omitted.

2.5 For the determination of dissolved organic carbon (DOC), the unpreserved sample is filtered and then analyzed the same as TOC.

2.6 For the determination of total inorganic carbon, the unpreserved sample is injected into the reaction vessel, where phosphoric acid converts the inorganic carbon to carbon dioxide. The carbon dioxide produced is measured by the infrared detector.

3.0 Definitions

3.1 Total Carbon (TC): The sum of inorganic carbon and organic carbon.

3.2 Total Inorganic Carbon (TIC): The carbon measured as a result of acidification of the sample. This includes carbonates and bicarbonates.

3.3 Total Organic Carbon (TOC): The carbon measured as a result of oxidation of the sample after the removal of inorganic carbon.

3.4 Dissolved Organic Carbon (DOC): The carbon measured by the analysis of a filtered sample, using the procedure for TOC determination.

3.5 Non-Purgeable Organic Carbon (NPOC): The non-volatile organic carbon which is not eliminated by evaporation during the sparging process. NPOC is identical to the TOC obtained using the acidification and sparging process described in this SOP.

3.6 Non-Dispersive Infrared Analyzer (NDIR): The detector used in most TOC analyzers to measure the carbon dioxide produced. The NDIR outputs an analog signal that generates a peak, the area of which is calculated by a data processor.

3.7 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, "Quality Assurance Program," for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 The openings of the microliter syringe for injection limit the particle size that can be analyzed. Larger particulate matter may cause erratic results or instrument clogging and should be removed prior to analysis. It is recommended that solids be allowed to settle out prior to injection. Any alteration of sample homogeneity should be documented accordingly.

4.2 Carbonates and bicarbonates in excess may interfere with TOC results. TIC is normally removed through the acidification and sparging step of this analysis. Sufficient sparging must be used to remove all inorganic carbon from acidified samples.

4.3 Due to the initial purging step to remove inorganic carbon, purgeable organic carbon (POC) compounds may not be retained and the TOC result may be biased low.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 The auto sampler has a probe that is sharp; use caution to avoid puncture wounds.

5.3.3 The furnace is very hot and can cause severe burns if touched.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Phosphoric Acid	Corrosive	1 mg/m^3 (TWA)	Inhalation is not an expected hazard unless misted or heated to high temperatures. May cause redness, pain, and severe skin burns. May cause redness, pain, blurred vision, eye burns, and permanent eye damage.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3 (TWA)	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions. 2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 TOC analyzer with autosampler, computerized operating system, and TOC instrument control and analysis software.

The laboratory currently uses two TOC analyzers:

- Shimadzu model TOC-VCSH with a Shimadzu ASI-V autosampler
- Shimadzu model TOC-VCPN with a Shimadzu ASI-V autosampler.

6.1.2 Balance, analytical, capable of weighing to the nearest 0.0001 g

6.2 Supplies

6.2.1 Disposable glass autosampler tubes.

6.2.2 Syringe filter, 0.45 µm.

6.2.3 Miscellaneous laboratory glassware.

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Refer to the TOC analyzer user's manual for additional reagents that are specific to the analyzer, e.g., TOC catalyst, sparge gas, CO_2 absorber, etc.

7.3 Reagent Water

ASTM Type II water with a resistivity of 1 Megohm-cm or greater. The TestAmerica Denver deionized water supply meets this requirement with a resistivity of at least 10 Megohm-cm.

7.4 Sulfuric Acid (H_2SO_4), concentrated

Must meet TestAmerica specifications for quality, purity, and handling as described in TestAmerica SOP No. CA-Q-S-001. A listing of approved lots is posted by the QA group.

CAUTION: Always add concentrated acid, very slowly and carefully, to water to avoid splashing.

7.5 Sulfuric Acid, 0.2 %

7.5.1 In a 1 L volumetric flask, carefully add 2 mL of concentrated sulfuric acid to approximately 800 mL of reagent water. Dilute to 1 L with reagent water.

7.5.2 This reagent is used as the solvent for making standards. Alternatively, the standards may be made up in reagent water and acidified with sulfuric acid to pH <2.

7.6 Phosphoric Acid (H_3PO_4), 5% v/v (or the instrument manufacturer's specified equivalent)

Carefully add 50 mL of concentrated phosphoric acid to 950 mL of reagent water. Other volumes of the solution may be made by maintaining the same proportions.

7.7 Nitrogen or Purified Air

7.7.1 The gas used must be free of CO_2 and contain less than 1 ppm hydrocarbons as methane.

7.7.2 TA Denver utilizes 99.999% purity compressed air for the instrument analysis.

7.8 TOC Stock Calibration Standard, 1,000 mg/L

7.8.1 This standard is purchased from a commercial supplier or it may be prepared as detailed below.

7.8.1.1 Dissolve 2.128 g of potassium hydrogen phthalate (KHP) in about 600 mL reagent water in a 1000 mL volumetric flask.

7.8.1.2 Dilute to 1000 mL with reagent water.

7.8.1.3 Acidify to pH < 2 with H_2SO_4.

7.9 CCV Working Standard, 25 mg/L

Prepare the CCV by diluting 5 mL of the TOC Stock Calibration Standard (Section 7.8) to 200 mL with 0.2% sulfuric acid (Section 7.5) in a 200 mL volumetric flask.

7.10 Matrix Spike Samples, 25 mg/L

7.8.1 Spike 48.75 mL of the sample with 1.25 mL of the 1000 mg/L TOC Calibration Stock standard.

NOTE: SM 5310B requires the spike to be from the second source standard (ICV).

7.11 TOC ICV Stock Standard, 1,000 mg/L

7.11.1 This standard is purchased from a second source or it may be prepared from a second source as detailed below.

7.11.1.1 Dissolve 2.128 g of potassium hydrogen phthalate (KHP) in about 600 mL reagent water in a 1000 mL volumetric flask.

7.11.1.2 Dilute to 1000 mL with reagent water.

7.11.1.3 Acidify to pH < 2 with H_2SO_4.

7.11.1.4 The source of the reagents for this standard must be from a different source than those used for the Calibration Stock.

7.12 ICV Working Standard, 20 mg/L

Prepare the ICV by diluting 1.0 mL of the ICV Stock Standard (Section 7.11) to 50 mL with 0.2% sulfuric acid (Section 7.5) in a 100 mL volumetric flask.

7.13 LCS Working Standard, 25 mg/L

Prepare the LCS by diluting 5.0 mL of the Calibration Stock Standard (Section 7.6) to 200 mL with 0.2% sulfuric acid (Section 7.5) in a 200 mL volumetric flask.

NOTE: SM 5310B requires the spike to be from the second source standard (ICV).

7.14 Inorganic Carbon Removal Efficiency Check, 25 mg/L

Spike 48.75 mL of reagent water with 1.25 mL of the 1000 mg/L TOC Calibration Stock standard. This sample will be acidified at the purge.

7.15 TOC Working Calibration Standards

Dilute the TOC Stock Standard (Section 7.8) with 0.2% sulfuric acid (Section 7.5) as summarized in the following table:

Level	TOC Stock Conc (mg/L)	Volume of Stock (mL)	Final Volume (mL)	TOC Conc (mg/L)
1	1000	0	100	0
2	1000	0.1	100	1.0
3	1000	0.5	100	5.0
4	1000	1.0	100	10.0
5	1000	2.5	100	25.0
6	1000	5.0	100	50.0

7.16 TIC Stock Standard, 1000 mg/L

Dissolve 1.75 g of sodium bicarbonate and 2.209 g of sodium carbonate in about 250 mL of reagent water in a 500 mL volumetric flask. Dilute to 500 mL with reagent water.

7.17 TIC Working Standards

Dilute the TIC Stock Standard (Section 7.16) with reagent water as summarized in the following table:

Level	TOC Stock Conc (mg/L)	Volume of Stock (mL)	Final Volume (mL)	TOC Conc (mg/L)
1	1000	0	100	0
2	1000	0.1	100	1.0
3	1000	0.5	100	5.0
4	1000	1.0	100	10.0
5	1000	2.5	100	25.0
6	1000	4.0	100	40.0

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sampling and storage of samples in glass containers is preferable. Sampling and storage in plastic bottles is permissible if it is established that the containers do not contribute organic contaminants to the sample.

8.2 Because of the possibility of oxidation or bacterial decomposition of some components of aqueous samples, water samples for TOC and DOC must be acidified to pH < 2 with sulfuric or hydrochloric acid at the time of sampling. Samples for TIC should not be acidified. Samples must be maintained cool, at ≤ 6°C and stored in the dark.

8.3 The holding times for TOC and DOC are 28 days. The holding time for TIC is 14 days, the same as it is for alkalinity.

8.4 Samples requiring DOC (Dissolved Organic Carbon) should be field filtered using a 0.45-micron filter.

8.4.1 If the filtration must be performed in the laboratory, the samples should be filtered through a 0.45-micron filter and a filtered method blank must be prepared and analyzed along with the batch of DOC samples.

8.4.2 Filter a sufficient amount of deionized water to prepare a blank and LCS.

8.4.3 Acidify the filtered blank to a pH < 2 with H_2SO_4.

NOTE: Field filtering is preferred, because the sample should be filtered prior to acidification.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Sample QC - The following quality control samples are prepared with each batch of samples.

Quality Controls	Frequency	Control Limit
Method Blank (MB)[1]	1 in 20 or fewer samples	< ½ Reporting Limit
Laboratory Control Sample (LCS)[2]	1 in 20 or fewer samples	Statistical Limits but no wider than 80-120%[4]
Matrix Spike (MS)[3]	1 in 10 or fewer samples	Statistical Limits [4]
MS Duplicate (MSD)[3]	1 in 10 or fewer samples	Statistical Limits [4]
Inorganic Carbon Removal Efficiency Check	1 in 20 or fewer samples	< Reporting Limit

[1] The blank consists of 0.2% sulfuric acid taken through the entire procedure as if it were a sample for TOC. The Blank for TIC is reagent water.
[2] LCS Duplicate (LCD) is performed only when insufficient sample is available for the MS/MSD or when requested by the client/project/contract.
[3] The sample selection for MS/MSD is randomly selected, unless specifically requested by a client.
[4] Statistical control limits are updated annually and are updated into LIMS.

NOTE 1: Recommended corrective actions are listed in Attachment 1.

NOTE 2: The MS/MSD pair or the LCS/LCSD pair is used to determine precision for the analysis. A separate sample duplicate is, therefore, not prepared.

9.3 Instrument QC

Step	Standards	Type	Control Limit	Frequency
Initial Cal (TOC)	6 Calibration standards. See section 7.12 for concentrations.	Linear	0.995 correlation coefficient or greater	Initially, whenever the catalyst is changed, or when continuing calibration verification fails acceptance criteria or at least every 3 months.
Initial Cal (TIC)	6 Calibration standards. See section 7.14 for concentrations.	Linear	0.995 or greater	Initially, whenever the catalyst is changed, or when continuing calibration verification fails acceptance criteria.
ICV	Initial calibration verification	Second source	90-110%	Initially or immediately after the ICAL.
ICB	Initial calibration blank	0.2% sulfuric acid for TOC, reagent water for TIC	Less than RL	After the ICV.
CCV	Continuing Calibration Verification	See section 7.9	90-110%	Every 10 or fewer samples and after the last sample.

Step	Standards	Type	Control Limit	Frequency
CCB	Continuing Calibration blank	0.2% sulfuric acid for TOC, reagent water for TIC	Less than RL	After every CCV.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

10.3.1 Check the pH of the sample. If the pH is >2, add concentrated sulfuric acid drop wise until the pH is <2. Document the initial pH and any acid additions on the bench sheet.

10.3.2 If the samples are to be analyzed for TIC, use the unpreserved sample volume. Verify this by checking that the pH is >2.

10.3.3 If the sample is to be analyzed for DOC, it should be field filtered prior to preservation. Filter the sample through a 0.45-μm filter and document the filtration on the benchsheet. The first few milliliters of filtered sample should be discarded prior to collecting filtered sample for analysis.

10.3.3.1 If filtered in the lab, then also prepare a filtered method blank by filtering deionized water and adjusting the pH with 0.2% sulfuric acid to a pH < 2.

10.3.4 Prepare the Inorganic Carbon Removal Efficiency Check as described in Section 7.14. At the purge, acidify with sulfuric acid to a pH of <2. Analyze after acidification as described in Section 10.5. The TOC result obtained must be less than the reporting limit. If not, corrective action must be taken. See Attachment 1.

10.4 Calibration

10.4.1 Ensure that the TOC analyzer is set up and ready for use as described in the user's manual. Document daily instrument checks and maintenance in the instrument maintenance logbook.

10.4.2 The TOC analyzer is computer controlled and equipped with an autosampler so that calibration standards and samples can be analyzed in an automated sequence. The instrument software processes the raw

data, calculates the calibration function that is used for samples, and calculates results for each sample using the established calibration.

10.4.3 Set up the instrument software to perform calibration. Load the calibration blank and standards in the autosampler and run the calibration.

NOTE: Calibration standards and batch samples are typically loaded and run as an automated sequence. The instrument software uses the calibration standard data to calculate the calibration function and then uses this function to calculate sample results. The calibration is valid for 3 months as long as all QC continue to pass acceptance criteria. See Section 10.5.4 for a typical analytical sequence.

10.4.4 The instrument software uses a least-squares linear regression for the calibration. Calibration using least-squares linear regression produces a straight line that does not necessarily pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response (peak area) versus the concentration of the standards. See Section 11 for calculations.

10.4.5 Evaluation of the Linear Least-Squares Regression Calibration Function:

10.4.5.1 With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting of the linear function is recommended to optimize the accuracy at low concentrations.

10.4.5.2 Note that the August 7, 1998 EPA memorandum “Clarification Regarding Use of SW-846 Methods”, Attachment 2, Page 9, includes the statement “The Agency further recommends the use of this for weighted regression over the use of an unweighted regression.”

10.4.6 Detailed calibration equations can be found in the corporate SOP, CA-Q-S-005, “Calibration Curves” and under the public folder, Arizona Calibration Training.

10.4.7 It is not appropriate to use an internal standard for this method. Calibration and quantitation are performed using the external standard method.

10.5 Sample Analysis

10.5.1 Follow the manufacturer’s instructions for setting up and operating the TOC analyzer.

10.5.2 Turn on power to the TOC analyzer and allow it to warm up for at least 15 minutes prior to analysis.

10.5.3 Use the instrument software to set up the operating conditions for the analysis.

10.5.4 Create a sample table of the sequence of samples to be analyzed, including all QC samples. Standards and samples should be analyzed in the following sequence and the order of analysis must be recorded on the bench sheet:

NOTE: Method 9060 requires analysis of samples in quadruplicate, and Standard Methods 5310B requires duplicate analysis. Quadruplicate analysis of each sample, regardless of the specified method, is recommended. Record the order of analysis on the bench sheet.

- ICAL Standards, ICV, and ICB (if needed), or CCV and CCB
- LCS
- LCSD (if needed)
- Method Blank
- Inorganic Carbon Removal Efficiency Check standard
- 9 sample injections
- CCV
- CCB
- 10 sample injections
- Repeat the sequence of up to 10 samples between CCV/CCB pairs, as required, to complete each run. Each lot must be bracketed by a CCV/CCB pair.

10.5.5 Pour each sample and QC sample into an autosampler vial and load the vials into the autosampler in the established analytical sequence.

10.5.6 Verify that the instrument background is stable prior to starting analysis.

10.5.7 Use the instrument software to start the analytical sequence. Samples and standards are automatically injected and analyzed by the instrument and the analysis may proceed unattended.

10.5.8 The instrument software statistically evaluates replicate results for outliers based on the mean and standard deviation for the four results. The instrument will automatically inject another aliquot if the set of four results includes a statistical outlier.

10.5.9 Dilute and reanalyze any samples whose concentration exceeds the highest standard.

10.5.10 Due to potential carryover from high samples, examine carefully any result that follows a sample that is extremely high in TIC or TOC. If the TIC or TOC result in the subsequent sample is greater than the reporting limit, then reanalyze the sample to rule out carryover from the preceding high sample.

10.5.11 Once analysis is complete, dispose of any sample leftover in the vials as specified in Section 14 and clean up the work area.

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S-005 "Calibration Curves" and under the public folder, Arizona Calibration Training.

11.2 The instrument response is treated is the dependent variable (y) and the concentration as the independent variable (x). The regression produces the slope and intercept terms for a linear equation in the following form:

$$y = ax + b \qquad \text{Equation 1}$$

Where:

y = Instrument response (peak area).
x = Concentration of the target analyte in the calibration standard.
a = Slope of the line.
b = The y-intercept of the line.

11.3 To calculate the concentration in an unknown sample, the regression equation is solved for concentration, resulting in the following equation, where x is now the concentration of the target analyte in the unknown sample extract:

$$x = \frac{y - b}{a} \qquad \text{Equation 2}$$

11.4 The instrument software processes all raw data and reports results for each sample based on the calibration curve. If the sample was diluted for analysis then calculate the final result for the sample by multiplying the result reported by the instrument by the appropriate dilution factor as shown below.

Sample Conc (mg/L) = Measured Conc (mg/L) *x* Dilution Factor *Equation 3*

11.5 Accuracy

11.5.1 Percent recovery for the ICV, CCV or LCS is calculated using Equation 2.

$$\%\ Recovery = \frac{observed\ concentration}{known\ concentration} \times 100 \qquad \textit{Equation 4}$$

11.5.2 Matrix spike and Matrix spike duplicate recoveries are calculated using Equation 4.

$$MS\ or\ MSD\ \%\ Recovery = \left(\frac{SSR - SR}{SA}\right) \times 100\% \qquad \textit{Equation 5}$$

Where:

SSR = observed concentration in spiked sample
SR = observed concentration in unspiked sample
SA = concentration of spike added to sample

11.6 Precision (RPD)

$$RPD = \frac{R_1 - R_2}{(R_1 + R_2)/2} \times 100$$ *Equation 6*

Where:
R_1 = Measured concentration for first sample
R_2 = Measured concentration for second sample

11.7 Reporting Sample Results

11.7.1 Report the TOC concentration for each of the replicate results (four for Method 9060A and two for SM 5310B). This provides the range of results. In addition, report the average of the replicates. Reporting both the range and the average is a Method 9060A requirement.

11.7.2 The reporting limit is 1.0 mg/L. Samples with measured concentrations greater than 50.0 mg/L TOC or 40.0 mg/L TIC must be diluted and reanalyzed. Dilutions required for other reasons should be explained in an NCM or other communication to the laboratory Project Manager so that the final report case narrative explains the analytical problem.

11.7.3 All associated data are entered or uploaded into the LIMS as required.

11.7.4 Unless special instructions indicate otherwise, samples less than the reporting limit are reported as ND.

11.8 The initial data review is performed by the analyst, and a second-level review is performed by the area supervisor or designee. Both reviews are documented on a Data Review Checklist. See SOP DV-QA-0020 for a copy of the checklist and for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

12.2.1 An initial demonstration of capability for each method must be performed prior to analyzing samples.

12.2.1.1 The initial demonstration consists of the preparation and analysis of a QC check sample containing all of the standard analytes for the method, as well as a method detection limit (MDL) study.

12.2.1.2 Four aliquots of the QC check sample are analyzed with the same procedures used to analyze samples, including sample preparation.

12.2.1.3 The mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP No. DV-QA-0024.

13.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, Waste Management and Pollution Prevention, of the Corporate Environmental Health and Safety Manual, and Policy No. DV-HS-001P, Waste Management Program.

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Client sample/instrument process waste – Waste Stream F (Aqueous Acidic)

14.2.2 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper

management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition and all promulgated updates, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, January 2005.

15.1.1 Method 9060A, "Total Organic Carbon,", Revision 1, November 2004.

15.1.2 Method 9060, "Total Organic Carbon," Revision 0, September 1986.

15.2 "Standard Methods for the Examination of Water and Wastewater, 20th Edition; Clesceri, L.S.; Greenberg, A.E.; Eaton, A.D.; Editors; American Public Health Association, American Water Works Association, and Water Environment Federation, 1998 (and on-line version of the manual)

15.2.1 Method 5310B-1996, "Total Organic Carbon (TOC) - High-Temperature Combustion Method.

15.2.2 Method 5310B-2000, "Total Organic Carbon (TOC) - High-Temperature Combustion Method.

15.3 TOC-VCSH/CSN, Total Organic Carbon Analyzer, User's Manual, M393-E187A, 2001, Shimadzu Corporation, Kyoto, Japan.

16.0 Method Modifications

Item	Method	Modification
1	SM 5310B	Although SM 5310B requires only duplicate analyses of samples, each sample is analyzed in quadruplicate as required by SW-846 Method 9060A. The results of the four analyses are reported, rather than reporting the range and average.
2	9060, 9060A	SM 5310B requires an MS/MSD every 20 samples. This SOP requires an MS/MSD every 10 samples, however each sample is analyzed in quadruplicate instead of duplicate (see Item 1).
3	SM 5310B	SM 5310B requires a MB with a result of < ½ the RL as part of the IDOCs. Any data with results less than the RL are flagged as "estimated" values.
4	9060, 9060A	Samples are purged with air according to the instrument manufacturer's specifications. The limited sample volume used to perform the analysis requires less than the ten-minute purge specified in SW-846 Method 9060A.
5	9060, 9060A and SM 5310B	Samples are not homogenized with a blender as stated in all published methods. SOP states solids should be allowed to settle out prior to injection (Section 4.1)
6	9060 and 9060A	These methods prepare standards in ASTM Type II water and do not specify acidification. All TOC standards and QC samples are

Item	Method	Modification
		prepared with 0.2% H_2SO_4 in accordance with SM 5310B.
7	SM 5310B	SM 5310B utilizes a sample to perform the efficiency check of inorganic carbon removal and verification that the results between the spiked and unspiked sample are the same. This procedure utilizes deionized water since most samples are preserved in the field. The amount of Total Organic Carbon recovered must be less than the reporting limit to demonstrate effective removal of all inorganic carbon.

17.0 Attachments

Table 1: Summary of QC samples

18.0 Revision History

- Revision 9, dated 06 February 2013
  - Added section 3.7
  - Added section 7.5.2 as alternative to preparing acidified standards
  - Added requirement for checking efficiency of inorganic carbon removal to section 7, 9 and 10
  - Added details for 2012 MUR QC requirements in text throughout to replace reference to work instruction
  - Modified acceptance criteria for method blank to reflect current practice
  - Revised section 11.7 to reflect current practice
  - Revised Method modification #2 to reflect current practice
  - Added method modification #7
  - Added Inorganic Carbon Removal Efficiency Check to QC table in Attachment 1

- Revision 8, dated 04 January 2013
  - Added section 9.4 for 2012 MUR QC requirements

- Revision 7.4, dated 27 July 2012
  - Updated Section 9.1, 10.1, 10.2 and 12.1 to reflect current practice
  - Moved calculations in section 10 to section 11; reorganized Section 11
  - Added section 11.8
  - Removed old item 2 in Method Modification table. SOP was revised to include this requirement in a previous revision

- Revision 7.3, dated 31 January 2012
  - Annual Technical Review
  - Added the new Section 2.5
  - Updated Section 7.8.1 to current volumes used.
  - Added the note to Section 7.8.1
  - Updated Section 7.10.1 to current volumes used.
  - Updated Section 10.1.2 to check the pH of the sample.
  - Updated Section 10.2 to include the use of the curve for 3 months.
  - Added Section 10.2.4.2.

  - Updated Section 10.2.4.3 to include Arizona calibration information.
  - Corrected formatting and grammatical errors.

- Revision 7.2, dated 28 February 2011
  - Source method review
  - Updated method reference section to include both 9060 and 9060A
  - Updated Method Modifications table
  - Updated sample preservation to include storing in dark per SW-846 holding time table
  - Formatting and grammatical changes throughout
  - Added section 11.1 referencing corporate SOP CA-Q-S-005 “Calibration Curves”

- Revision 7.1, dated 19 April 2010
  - Annual Review
  - Added section 6.3

- Revision 7, dated 13 March 2009
  - The amount of mLs used for analysis was changed from 25mL to 20mL
  - The standards listed in Section 7 were updated to those being used in the lab
  - The sample preparation section was updated to reflect current practices

- Revision 6, dated 01 February 2008
  - Integration for TestAmerica and STL operations.
  - Updated formatting
  - Removed all references to EPA 415.2

- Revision 5, dated 08 November 2006
  - Updated formatting consistent with Policy QA-001.
  - Incorporated all Interim Changes.
  - Incorporated Safety Bulletin to ensure that Sections 5, 14, and 15 comply with STL Corporate requirements.
  - Updated reference to specific TOC analyzers used in Section 6.
  - Deleted sodium persulfate reagent from Section 7. The TOC analyzers currently used employ combustion rather than a persulfate digestion.
  - Revised Section 9.1 to include a reference to QA-024.

- Revision 4, dated 30 July 2002
  - Program requirements for 10% MS/duplicate frequency included in Section 9.6.
  - Calibration section 10 rewritten for clarity and to specify least-squares linear regression.
  - Filtration information made specific to DOC analysis.
  - SOP revised to indicate that quadruplicate analysis is a requirement only for Method 9060. Method 415.2 requires duplicate testing.

- Revision 3, dated 22 March 2002
  - Interim changes regarding the Dohrmann TOC analyzer are incorporated.
  - Data review checklist added.
  - Push button operational instructions removed due to the variety of instruments in use. Operator manuals supplied by the vendors have these details.
  - Pollution prevention and waste management sections have been revised to match current practice.

Table 1.

Summary of QC Samples

QC Samples	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration (ICAL)	Initially and if CCV fails	Correlation coefficient ≥ 0.995	Correct problem and recalibrate.
Initial Calibration Verification (ICV)	At the start of each day following calibration and prior to sample analysis	90-110 % recovery	Recalibrate and reanalyze.
Initial Calibration Blank (ICB)	After ICV and prior to sample analysis	Less than reporting limit	Reprepare and reanalyze.
Method Blank	1 per batch of 20 samples	Less than ½ reporting limit	Recalibrate and reanalyze any samples analyzed with that batch
Laboratory Control Sample (LCS)	1 per batch of 20 samples	Meets laboratory historical limits (minimum method requirement is 80 to 120%)	Recalibrate and reanalyze.
Continuing Calibration Verification (CCV)	Between each group of 10 samples	90-110 % recovery	Recalibrate and reanalyze all samples since the last acceptable CCV.
Continuing Calibration Blank (CCB)	Between each group of 10 samples, following the CCV	Less than reporting limit	Reprepare and reanalyze.
Matrix Spike Sample (MS/MSD pair)	1 per 10 samples	Meets laboratory historical limits (minimum method requirement is 80 to 120%)	Supervisor's technical judgment based on other QC results and project requirements.
Inorganic Carbon Removal Efficiency Check	1 per batch	Less than reporting limit	Corrective action includes adjusting conditions such as sample volume, pH, purge-flow rate and purge time to obtain complete removal of inorganic carbon. Any samples analyzed before a passing efficiency check must be reanalyzed in a batch with a passing efficiency check.

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Title: Total Sulfide Sample Preparation and Titration [SW 9030B/ SW9034]

Approvals (Signature/Date):

Dave Elkin — 6/21/12 Date Wet Chemistry Supervisor	Adam Alban — 20 June 12 Date Health & Safety Manager / Coordinator
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1.0 Scope and Application

1.1 This SOP covers both the sample pretreatment procedure designed to remove interfering substances prior to analysis and the determination of the concentration of acid-soluble sulfide. It is based on SW-846 Methods 9030B and 9034.

1.2 This method does not measure acid-insoluble sulfides.

1.3 This method is applicable to the measurement of total acid-soluble sulfides in drinking water, surface and saline waters, domestic and industrial wastes and solid waste materials.

1.4 The reporting limit for water samples is 4 mg/L and for soil samples is 5 mg/Kg. Samples that contain more than 50 ppm sulfide should be diluted.

1.5 The analytical time is approximately 75 minutes per sample.

2.0 Summary of Method

2.1 The sulfide method is a two part method involving the distillation of the sample followed by titration of the collected scrubber solution.

2.2 The separation of sulfide from the sample matrix is accomplished by the addition of sulfuric acid to the sample in a closed system. The sample is then heated (for total sulfide) to 70 °C. The H_2S, which is formed, is carried by a nitrogen stream into a zinc acetate/formaldehyde gas scrubbing bottle. Under these conditions, it is precipitated out as ZnS.

2.3 The titration is accomplished by the addition of excess iodine to a sample which has been treated with zinc acetate to produce zinc sulfide. The iodide oxidizes the sulfide to sulfur under acidic conditions. The excess iodine is back titrated with sodium thiosulfate.

3.0 Definitions

Please refer to the Glossary of the TestAmerica Denver Quality Assurance Manual and SOP DV-QA-003P for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 Aqueous samples should be taken with a minimum of aeration to avoid the oxidation or volatilization of sulfide.

4.2 Reduced sulfur compounds, such as sulfite and bisulfite decompose in acid to form SO_2. The SO_2, if carried over into the scrubbing solution may yield false positives. The addition of formaldehyde in the scrubber solution removes this interference. This method shows no sensitivity to sulfite or bisulfite at concentrations up to 10 ppm.

4.3 Many metals (e.g., Hg, Cd, Cu) form insoluble sulfides and give low recoveries.

4.4 The iodometric method suffers interference from reducing substances that react with iodine, including thiosulfate, sulfite, and various organic compounds, both solid and dissolved. These compounds are common in some sample types, such as refinery waste and boiler feed water. Where these compounds are known to be present, the zinc hydroxide/sulfide precipitate can be centrifuged and washed with deionized water to remove the interferent.

4.5 High levels of color and turbidity may interfere.

4.6 If water samples are not preserved with zinc acetate, analysis must start immediately.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 Ensure cooling water is turned on to the distillation unit. Otherwise the samples may boil over and come into contact with the heating plates.

5.3.3 Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Formaldehyde	Toxic	0.75 ppm (TWA)	Inhalation may result in spasm, inflammation, and edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3 (TWA)	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Sodium Sulfide	Corrosive	10 ppm (TWA) 15 ppm (STEL)	Will form hydrogen sulfide (HS) gas if combined with strong acids. Inhalation of HS gas may be fatal. Symptoms include painful conjunctivitis, headache, nausea, dizziness, coughing and, in extreme cases, pulmonary edema and possible death. Irritant. Contact with skin can produce serious caustic burns with painful inflammation and possible destruction of tissue. Inflammation, tearing and pain may be expected. Severe contact can cause destruction of tissue.
Sodium Hydroxide	Corrosive	2 mg/m^3 (Ceiling)	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and with greater exposures, it can cause burns that may result in permanent impairment of vision, even blindness.
1 – Always add acid to water to prevent violent reactions. 2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Nitrogen gas.

6.2 Reaction vessels, 500 mL round-bottom flasks with 3 necks, 24/40 joints.

6.3 Addition funnels, 125 mL, 24/40 outlet joint.

6.4 Scrubber bottle, 250 mL.

6.5 Tygon tubing.

6.6 Glass tubing.

6.7 Hotplate, capable of maintaining 70°C ± 5°C.

6.8 Volumetric pipettes, various.

6.9 Burette, 25 mL, Class A.

6.10 Erlenmeyer Flasks, 250 mL and 500 mL.

6.11 Magnetic stirrer plate, magnetic stirrer bars, optional.

6.12 Assorted analytical glassware, as needed.

6.13 pH strips

6.14 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 All reagents listed herein shall be ACS Reagent Grade, unless specified otherwise.

7.2 Reagent Water

ASTM Type II water with a resistivity of 1 megohm-cm or greater. The TestAmerica Denver house deionized water meets this requirement with a minimum resistivity of 10 megohm-cm.

7.3 Sulfuric acid, concentrated.

7.4 Hydrochloric acid, concentrated.

7.5 Sulfide Standard Solution (Na_2S), approximately 1000 mg/L

Dissolve approximately 3.75 g of $Na_2S \bullet 9H_2O$ crystals in 400 mL reagent water in a 500 mL volumetric flask. Add 2 mL of 50 % sodium hydroxide and dilute to 500 mL. Standardize daily according to Section 10.4.1

7.6 Zinc acetate, 0.5 M

Dissolve 110 g of zinc acetate dihydrate in 200 mL of deionized water. Add 1 mL of concentrated HCl and dilute to 1 liter.

7.7 Formaldehyde, 37%

Obtain solution from a commercial vendor.

7.8 Hydrochloric Acid, 6 N (1:1)

Very carefully and slowly, and with constant mixing, add 250 mL of concentrated hydrochloric acid (HCl) to 250 mL of reagent water and mix. Allow to cool before use.

7.9 Starch Indicator

7.9.1 The starch indicator solution is purchased commercially.

7.9.2 Alternatively, to prepare the indicator solution in the lab, dissolve 2 g of laboratory-grade soluble starch and 2.0 g of salicylic acid, as a preservative, in 100 mL of hot reagent water. Mix, cool, and store in a labeled poly bottle.

7.10 Potassium Iodide (KI), crystals.

7.11 Sodium Thiosulfate, 0.0250 N

This solution is purchased as a standardized 0.0250 N solution.

7.12 Iodine Solution, 0.0250 N

This solution is purchased as a standardized 0.0250 N solution.

7.13 Sodium Hydroxide (NaOH), 50%

7.13.1 This solution is usually purchased from commercial sources.

7.13.2 If prepared in the lab, very carefully and slowly, with constant stirring, add 250 g of NaOH to 200 mL of reagent water in a beaker.

CAUTION: This solution gets very hot. Add the NaOH to the water slowly to allow the heat to dissipate.

7.13.3 Allow to cool, then transfer the solution to a 500 mL volumetric flask and dilute to volume with reagent water.

7.14 Sulfuric Acid, 20%

Very carefully and slowly, and with constant mixing, add 200 mL of concentrated sulfuric acid to 800 mL of reagent water. Cool to room temperature.

7.15 Reagent sand, such as Ottawa sand for use as blank solid matrix.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Water	HDPE	250 mL	NaOH/Zn Acetate pH>9 Cool, $\leq 6^{o}C$	7 Days	SW-846
Soil	Glass	4 oz jar	Cool, $\leq 6^{o}C$	7 Days	SW-846

NOTE: Samples should be collected with a minimum of aeration. **The sample bottle should be filled completely, excluding all head space, and sealed.** Analysis should commence as soon as possible, and samples should be kept in a cool, dark place until analysis begins.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via method comments in the LIMS and in the Quality Assurance Summaries (QAS) available in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Sample QC - The following quality control samples are prepared with each batch of samples.

9.2.1 Method Blank

A minimum of one method blank must be included in each QC batch of 20 or fewer field samples. The method blank consists of reagent water for batches of aqueous samples or Ottawa sand for batches of solid samples. Prepare and analyze the blank in the same manner as samples.

Acceptance criteria: The result for the method blank must be less than the reporting limit for the analyte of interest or less than 10% of the lowest analyte concentration found in the associated samples, whichever is higher. In the latter case, an NCM must be generated explaining the analyte detection in the blank. Note that some programs (e.g., DoD) require the maximum blank concentration to be less than one-half of the reporting or less than 10% of the lowest sample concentration.

Corrective Action: All samples associated with an unacceptable method blank must be re-prepared and reanalyzed after first checking all reagents and glassware for sources of contamination, checking the condition and cleanliness of the burette delivering the titrant, and correcting any problems found.

If the analyte was <u>not</u> detected in the samples, then the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

If there is insufficient sample for reanalysis, an NCM must be prepared and the client contacted by the laboratory Project Manager.

9.2.2 Laboratory Control Sample (LCS)

A minimum of one LCS must be included in each QC batch of 20 or fewer field samples. The LCS is prepared by spiking 250 mL reagent water or 50 g of Ottawa sand with 5 mL of the Sulfide Standard Solution (Section 7.5). The nominal spike concentration for the water LCS is 20 mg/L and for the solid LCS is 100 mg/Kg. The LCS is analyzed in the same manner as the sample distillates. A duplicate LCS (LCSD) may be prepared and analyzed to provide a measure of analytical precision if

required by the client or project and in cases where there is insufficient sample to prepare an MS and MSD.

Acceptance criteria: The recovery results for the LCS must fall within the established control limits. Control limits are set at ± 3 standard deviations around the historical mean and must be no wider than the limits specified in the reference methods or by specific projects.

Corrective Action: If LCS recoveries are outside of the established control limits, the system is out of control and corrective action must occur. If recoveries are above the upper control limit and the analyte of interest is not detected in samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative. In other circumstances, the entire batch must be re-prepared and reanalyzed. If reanalysis is not possible, an NCM must be prepared and the client contacted by the laboratory Project Manager.

9.2.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

One MS/MSD pair is required with each batch of 20 or fewer samples for total sulfide. The MS and MSD are prepared by adding 5 mL of the Sulfide Standard Solution to the sample aliquot required (Section 7.5). If insufficient sample volume is available for the preparation of an MS/MSD or a sample duplicate, a duplicate LCS may be analyzed.

Acceptance Criteria: The recovery results for the MS and MSD must fall within the established control limits, which are set at ± 3 standard deviations around the historical mean. The relative percent difference (RPD) between the MS and MSD, or between the sample and sample duplicate, must be less than the established RPD limit, which is set at 3 standard deviations above the historical mean.

Corrective Action: If analyte recovery or RPD falls outside the acceptance range, but the associated LCS recovery is in control, and all other QC criteria (e.g., continuing calibration verification) are met, then there is no evidence of analytical problems, and qualified results may be reported. The situation must be described in an NCM and in the final report case narrative. In other circumstances, the batch must be re-prepared and reanalyzed.

Document the failure in an NCM and note it in the final report.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

10.3.1 Prepare the scrubber bottles by adding 235 mL of deionized water to a 250 mL bottle. Add 10 mL of zinc acetate solution and 5mL of 37% formaldehyde.

10.3.2 Prepare reaction vessels, as follows:

10.3.2.1 Solids and Sludges

Weigh 50 g of soil or sludge into a 3-necked 500 mL round bottom flask. Add 250 mL of DI water and stopper immediately. The sample weight can be reduced to 25 ± 0.5 g if the matrix absorbs water or does not stir efficiently.

10.3.2.2 Liquids

Check the pH of the sample with wide-range pH paper and record on the benchsheet. Shake the sample container to suspend any solids and then quickly transfer 250 mL of sample with a graduated cylinder into a 3-necked 500 mL round bottom flask and stopper immediately.

10.3.3 Assemble the apparatus as shown in Attachment 1. Add 25 mL of concentrated sulfuric acid to an addition funnel and connect it to the reaction flask. Connect the nitrogen stream to the flask as shown in Attachment I. Be sure all fittings and joints are air-tight.

10.3.4 Adjust the nitrogen flow to about 5 bubbles per second in the scrubber bottle.

10.3.5 Once the gas flow has stabilized, purge the system for 15 minutes.

10.3.6 Add sulfide standard solution by pipette to the LCS and MS/MSD (if MS/SD are analyzed). Keep the tip of the pipette beneath the water surface and seal the vessel up tightly after addition. Spiking is normally done with 5 mL of sulfide standard solution (Section 7.5).

10.3.7 Add water to the water bath on each hot plate and turn on each stirrer so that the sample is stirred gently, without vortexing.

10.3.8 Open the addition funnel so that the concentrated sulfuric acid drips slowly into the sample. Some samples may react violently with the acid, in which case the addition rate of acid may be decreased.

10.3.9 Once all acid has been added, turn on the hot plate so reaction vessels will heat to 70 ± 5 °C.

10.3.10 Allow the reaction to proceed for 90 minutes, checking the temperature frequently. Record the start and end times of the distillation in the batch record.

10.3.11 Once the distillation is complete, use pH paper to check the pH of the spent solution in the reaction vessel. If the pH is not less than or equal to 1, reprepare the sample using more acid.

10.3.12 If the pH is less than or equal to 1, close the scrubber bottles and proceed to the analysis outlined in Section 10.5 for total sulfide determination by titration by Method 9034.

10.4 Calibration

10.4.1 Standardization of Sulfide Standard Solution

10.4.1.1 Pipette 20.0 mL of iodine solution (Section 7.12) into a 250 mL Erlenmeyer flask.

10.4.1.2 Add 2 mL of 6 N hydrochloric acid (Section 7.8).

10.4.1.3 Pipette 5.0 mL of the Sulfide Standard Solution (Section 7.5) into the flask, making sure that the delivery tip of the pipette is below the surface of the solution. Dilute to approximately 100 mL with reagent water.

10.4.1.4 Titrate with 0.0250 N sodium thiosulfate solution (Section 7.11) to a pale yellow straw color.

10.4.1.5 Add 1 mL of starch indicator solution (Section 7.9) and wait until a homogenous blue color develops.

10.4.1.6 Continue the titration until the blue color disappears. Record the volume of the sodium thiosulfate titrant used.

10.4.1.7 Calculate the sulfide concentration using the sulfide titration spreadsheet (Attachment 3).

10.4.1.8 Perform the titrations in duplicate. Use the average of the two results as the final sulfide concentration of the Sulfide Standard Solution.

10.5 Sample Analysis

10.5.1 Determination of Total Sulfide (Acid-Soluble Sulfides)

10.5.1.1 Transfer the contents of the bottle from 10.3.11 to a 500 mL Erlenmeyer flask. Gently swirl the collection bottle so that all precipitated zinc sulfide is collected. Rinse the bottle with reagent water to remove any remaining white precipitate and add the rinsate to the flask. The transfer should be accomplished with a minimum of agitation to minimize the exposure of the sample to air.

10.5.1.2 Add 2 mL of 6 N HCl (Section 7.8) to the distilled sample in the Erlenmeyer flask.

10.5.1.3 Using a volumetric pipette, dispense a known amount of 0.025 N iodine solution (Section 7.12) into the flask. The amount added needs to be in excess of the amount needed to oxidize the sulfide. This is typically 5 mL for "ND" samples and 20 mL for samples with sulfide in the range of the LCS samples. Add enough iodine solution to turn the liquid in the flask a deep amber color. Record the volume of iodine used.

NOTE: There must be enough iodine to oxidize the entire amount of sulfide present as zinc sulfide precipitate in the scrubber solution. Use about 1.5 mL of the 0.0250 N iodine solution for every mg of sulfide estimated to be in the sample. The amount of iodine necessary can be estimated by the amount of precipitate present in the scrubber solution. After addition of the iodine, the solution should be a deep amber color. If, in the analyst's opinion, the amount of iodine needed to oxidize the sulfide present in the sample will take more than 25 mL, a smaller sample aliquot may be taken for analysis. This volume must be measured and recorded.

10.5.1.4 If desired, add a stir bar and place the flask on a magnetic stirrer.

10.5.1.5 Titrate the solution with 0.0250 N sodium thiosulfate solution (Section 7.11) to a pale yellow color.

10.5.1.6 Add sufficient starch indicator solution (Section 7.9) to achieve a deep and homogeneous blue color. Typically this volume is approximately 1 mL.

10.5.1.7 Continue the titration until the blue color disappears.

10.5.1.8 Record the volume of sodium thiosulfate solution used.

11.0 Calculations / Data Reduction

11.1 All calculations are performed in the sulfide titration benchsheet (spreadsheet). For manual verification use the following calculations.

11.2 One mL of 0.0250 N iodine solution reacts with 0.4 mg of sulfide present in the titration flask. Use the following equation to calculate sulfide concentration:

$$S = \frac{[(A \times B) - (C \times D)] \times 16000}{V_s}$$ *Equation 1*

Where:

S = Concentration of sulfide in sample (mg/kg or mg/L)
A = Volume of iodine solution added (mL)
B = Normality of iodine solution
C = Volume of sodium thiosulfate solution (mL)
D = Normality of sodium thiosulfate solution
V_s = Volume (mL) or weight (g) of original sample aliquot

11.3 If the normality of the iodine solution is exactly the same as that of the sodium thiosulfate solution, i.e., 0.0250 N, the following calculation may be used instead of the equation in section 11.2:

$$S = \frac{(A - C) \times 400}{V_s}$$ *Equation 2*

Where:

S = Concentration of sulfide in sample (mg/kg or mg/L)
A = Volume of iodine solution added (mL)
C = Volume of sodium thiosulfate solution (mL)
Vs = Volume (mL) or weight (g) of original sample aliquot

11.4 LCS Percent Recovery

Use the following equation to calculate the percent recovery of sulfide in the LCS:

$$LCS\ \ \%Recovery = \frac{Measured\ \ Value}{True\ \ Value} \times 100\%$$ *Equation 3*

11.5 MS and MSD Percent Recovery

Use the following equation to calculate the percent recovery of the added sulfide in the MS and MSD samples:

$$\text{MS}\ \ \%\text{Recovery} = \frac{SSR - SR}{SA}$$ *Equation 4*

Where:

SSR = Spiked sample result (concentration of sulfide in the MS or MSD).

SR = Sample result (concentration of sulfide in the parent sample).

SA = Concentration of added spike (concentration of sulfide in the sample in addition to any native sulfide as the result of adding the spiking solution).

11.6 Relative Percent Difference (RPD)

Use the following equation to calculate the relative percent difference between two analytical results (e.g., MS and MSD, LCS and LCSD, sample and sample duplicate).

$$RPD = \frac{\left|(R_1 - R_2)\right|}{1/2(R_1 + R_2)} \times 100\% \qquad \textit{Equation 5}$$

Where:

R_1 = Result for first sample (MS, LCS, or sample).

R_2 = Result for duplicate sample (MSD, LCSD, or sample duplicate).

11.7 All data undergo first and second level review using a checklist. See SOP DV-QA-0020 for a copy of the checklist and for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. The current MDL value is maintained in the TestAmerica Denver LIMS.

12.2 Demonstration of Capabilities

12.2.1 All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.2 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.3 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.4 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.5 Further details concerning demonstrations of proficiency are described in SOP# DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.2.2 Scrubber waste – Aqueous Acidic (Reactivity) - Waste Stream F

14.2.3 Contents of reaction vessel – Aqueous Acidic (Reactivity) - Waste Stream F

14.2.4 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition and all promulgated updates, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, January 2005.

15.1.1 Method 9030B: Acid-Soluble and Acid-Insoluble Sulfides: Distillation, Revision 2, December 1996.

15.1.2 Method 9034, Titrimetric Procedure for Acid-Soluble and Acid Insoluble Sulfides, Revision 0, December, 1996.

16.0 Method Modifications:

Item	Method	Modification
1	SW 9030B	In this SOP the distillation apparatus uses only one scrubber.
2	SW 9030B	For total sulfide, 25 mL of concentrated sulfuric acid is added to the system without first titrating the sample. After the 90 minute reaction period, the spent sample solution pH is measured. If the pH is not ≤ 1.0, the sample is re-distilled using additional sulfuric acid.
3	SW 9034	Rinse solution of standardized 0.0250 N iodine, 1 mL of 6 N HCl, and reagent water is not used in the above procedure. As samples are preserved with 1% sodium hydroxide and zinc acetate, and the total sulfides are preserved with formaldehyde and zinc acetate, rinsing the bottles with reagent water introduces very minimal loss of sulfide due to oxidation.
4	SW 9034	The sodium thiosulfate and iodine solutions are purchased standardized from a vendor and therefore are not standardized in the laboratory.
5	SW 9034	The Method 9034 procedure is to add the iodine solution into a 500 mL flask, bring to 100 mL with reagent water, add acid, and pipette the scrubber solutions from method 9030 under the iodine solution. The scrubber solutions are approximately 200 mL. Due to the large volume of scrubber solution, the laboratory transfers the scrubber solutions into a flask and then adds the acid and iodine solution.
6	SW 9030B	Soil samples are refrigerated upon receipt and are not preserved with zinc acetate. The laboratory uses the 7 day holding time stated in SW-846. Since sample composition and moisture content vary so widely, it is difficult to preserve the sample in the field as prescribed. It is recommended that the sample be taken with no headspace.
7	SW 9030B	Aqueous samples are measured volumetrically in graduated cylinders, not by weight as indicated in the source method. Generally the liquid samples received by the lab are water rather than non-aqueous wastes.

17.0 Attachments

Attachment 1: Distillation Apparatus
Attachment 2: Example Sample Preparation Benchsheet - LIMS

Attachment 3: Example Titration Benchsheet – Excel Spreadsheet
Attachment 4: Example Titration Benchsheet - LIMS

18.0 Revision History

- Revision 3.3, dated 26 June 2012
  - Revised section 7 and references to standard solution
  - Revised references in section 8 to SW-846
  - Corrected Equation 1 (Section 11)
  - Updated method modifications for soil preservation, dynamic range, measurements for aqueous samples.
  - Source method review
  - Updated attachments
  - Formatting and grammatical changes throughout

- Revision 3.2, dated 31 May 2011
  - Annual Technical Review
  - Updated Attachments 2-4.

- Revision 3.1, dated 05 May 2010
  - Annual Review
  - Added section 6.1

- Revision 3, dated 27 March 2009
  - Incorporated method 9034 into this SOP
  - Fixed formatting and minor grammatical errors

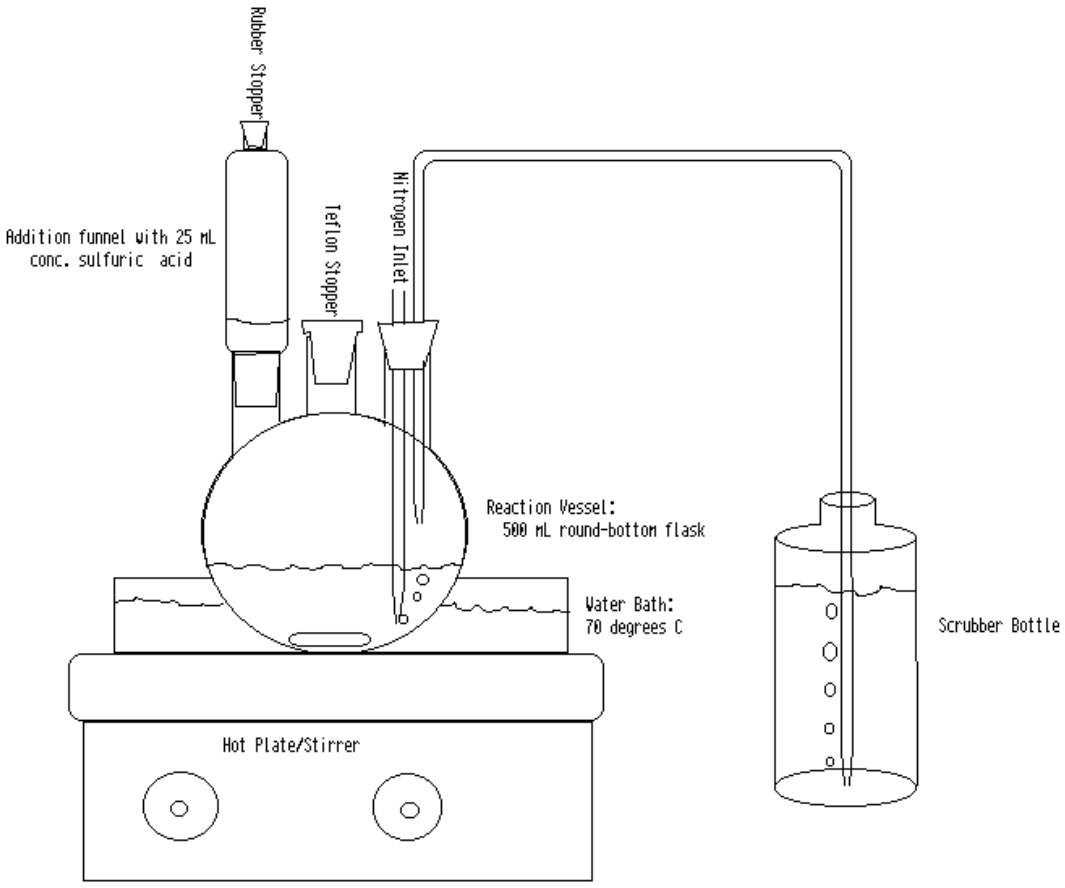
- Revision 2, dated 21 March 2008
  - Integration for TestAmerica and STL operations.
  - Updated formatting.
  - Updated method references.
  - Technical review performed.

- Revision 1.1, dated 21 November 2006
  - For this minor revision, the technical content of this SOP was not reviewed or updated. The purpose of this minor revision is to incorporate the Safety Bulletin information to ensure compliance with STL Corporate requirements. In addition, Section 9.1 was revised to reference Policy QA-024 for specific QC requirements for federal programs, any existing interim changes were incorporated, and formatting was updated consistent with Policy QA-001.

- Revision 1, dated 07 March 2002
  - Quanterra changed to STL.
  - Added Data review checklist to Appendix III.
  - Updated waste section.

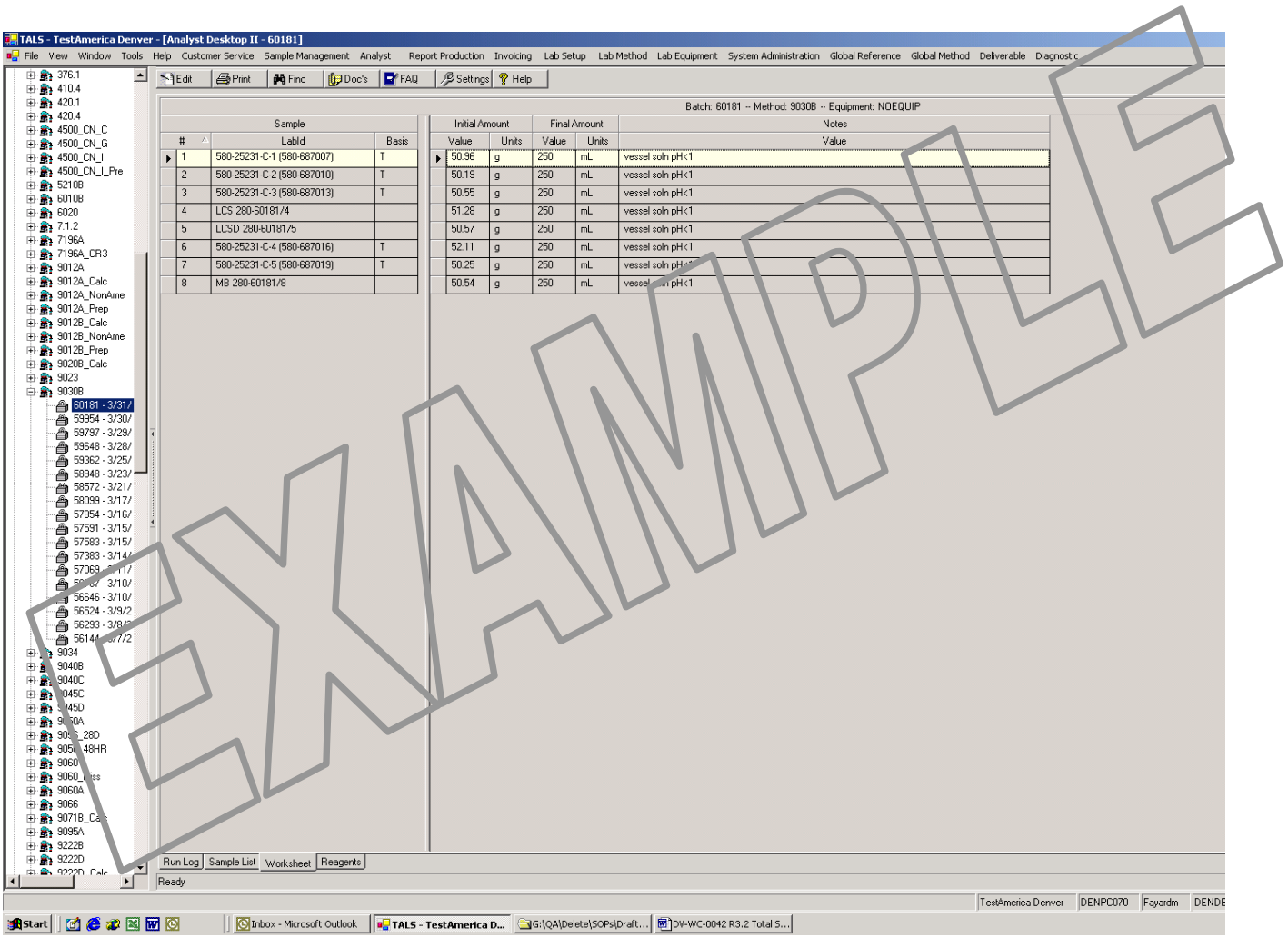
Attachment 1.

Distillation Apparatus



Attachment 2.

Example Sample Preparation Benchsheet - LIMS



EXAMPLE

Attachment 3.
Example Titration Benchsheet – Excel Worksheet

Laboratory Bench Sheet — **TestAmerica Denver**

Sulfide by Titration 9030B

Analyst:	M. Plumb	Titration Solutions		SOP Information:		RL/MDL				
Date:	5/29/2011	Solution 1:	Iodine	Number:	DV-WC-0042	MDL	2.4			
QC Batch:		Source:	Ricca	Revision:	4.1	Rep. Limit	5			
MS Run:		Lot #:	0753-11	Calibration Information						
ICV Information		Normality:	0.025	Std#: sfd cal int	296					
Source/Ver-Lot#:		Exp. Date:	12/31/2011	Prep Date:	5/18/2011	Starch Indicato				
Prep Date:		Solution 2:	sodium thiosulfate	Made By:	PMP	RICCA				
Made By:		Source:	Ricca	Concentration (mg/L)		04 0600 11				
Concentration:		Lot #:	0704-11	Expiration Date:	5/18/20 1	expire :	12/19/2008			
Expiration Date:		Normality:	0.025	LCS True Value	80.4					
ICV True Value:		Exp. Date:	6/31/2012	Spike True alue:	8 .40	4/26/20 12				

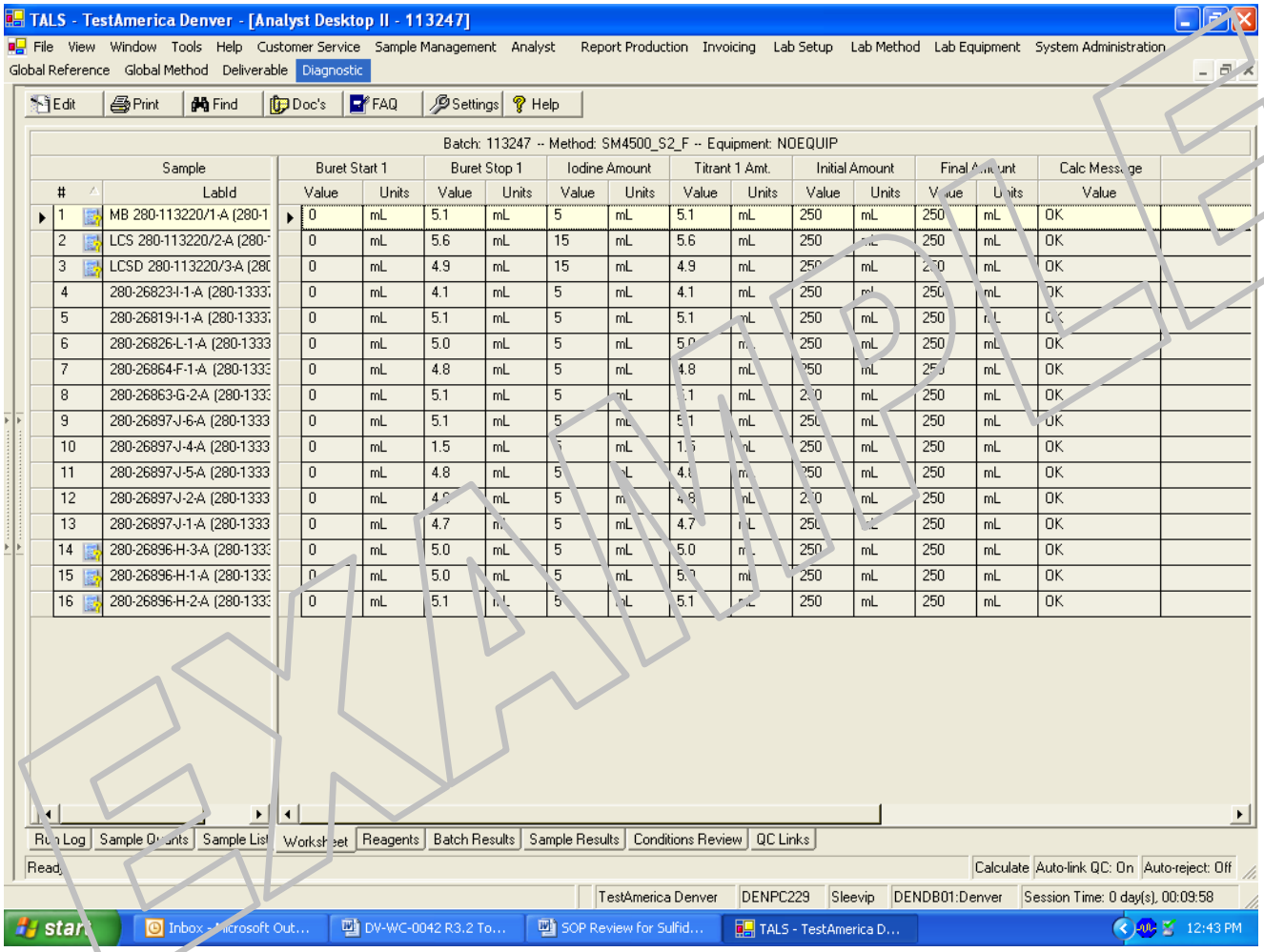
Sample ID	Final Volume (mL)	Buret Start	Buret Stop	mL Iodine	Final mL	Concen ratn mg/L	sampl weight	Dilution Factor	inal Con mg L, mg/k	% R c.
CAL	5	0.00	9.90	20	9.90	808.00	1	1	8 8.00	
CAL	5	0.00	10.00	0	0.00	8 0.00	1	1	80 .00	
MB	250	0.00	4.90	5	4. 0	0 6	5 .00	5.00	NL	
LCS	250	0.00	9.2	15	9.20	9.2	50 0	5.00	46.4	57.71
LCSD	250	0.00	9.40	15	9.40	8. 6	50.0	5.00	44.80	55.72
15033-1	250	0.00	5.10	5	5. 0	-0.1 6	0.00	.00	ND	
15033-2	50	0.00	3. 0	5	3. 0	2.4	5 .00	.00	12.00	
15033-3	250	0.00	5.0	5	5.00	0.00	50 0	5.00	ND	
15081-3 MS	250	0.00	4.1	5	4.10	1.44	0.00	5.00	7.20	
150 1-3 MSD	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-1	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-2	250	0.00	4.40		4.	0.96	50.00	5.00	4.80	
15086-3	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-4	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-5	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-6	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-7	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-8	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
1508 -9	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-10	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-11	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-12	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-13	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-14	250	0.00	4.40	5	4.40	0.96	50.00	5.00	4.80	
15086-15	250	0.00	4.40	5	4.40	0.96	25.00	10.00	9.60	
15086-16	250	0.00	4.40	5	4.40	0.96	25.00	10.00	9.60	
15086-17	250	0.00	4.40	5	4.40	0.96	1.00	250.00	240.00	
15086-18	250	0.00	4.40	5	4.40	0.96	1.00	250.00	240.00	

G:\QA\Edit\FORMS\Wet Chemistry\Sulfide by Titration_Solid_9030B_Master.xls
Revision 5- June 2012

EXAMPLE

Attachment 4.

Example Titration Benchsheet - LIMS



EXAMPLE

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA LABORATORIES WEST SACRAMENTO
880 Riverside Parkway
West Sacramento, CA 95605
Douglas Weir Phone: 916 3744 389

ENVIRONMENTAL

Valid To: January 31, 2014 Certificate Number: 2928.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Inductively Coupled Plasma (ICP), ICP-Mass Spectroscopy, Atomic Absorption Spectroscopy (flame), Gas Chromatography(GC), GC- Mass Spectroscopy, High Resolution Gas Chromatography/High Resolution Mass Spectroscopy, Liquid Chromatography(LC),LC- Mass Spectroscopy, Ion Chromatography, Spectrophotometry, Misc.- Electronic Probes

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Metals				
Aluminum	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Antimony	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Arsenic	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Barium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Beryllium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Cadmium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Calcium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Chromium (Total)	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Chromium (Hexavalent)	EPA 7196A	EPA 7196A	-------	EPA 3005A/3010A/3050A
Cobalt	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Copper	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Iron	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Lead	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Magnesium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A

5301 Buckeystown Pike, Suite 350 | Frederick, Maryland 21704-8373 | Phone: 301 644 3248 | Fax: 301 662 2974 | www.A2LA.org

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Manganese	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Mercury	EPA 7470A	EPA 7471A	-------	EPA 3005A/3010A/3050A
Molybdenum	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Nickel	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Potassium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Selenium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Silver	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Sodium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Thallium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Vanadium	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Zinc	EPA 6010B/6020	EPA 6010B/6020	-------	EPA 3005A/3010A/3050A
Nutrients				
Nitrate	EPA 353.2/9056A/300.0	EPA 353.2/9056A/300.0	-------	----------
Nitrate-nitrite	EPA 353.2/ SM4500-NO3 F	EPA 353.2	-------	----------
Nitrite	EPA 353.2/9056A/300.0	EPA 353.2/9056A/300.0	-------	----------
Orthophosphate	EPA 9056A/300.0	EPA 9056A/300.0	-------	----------
Wet Chemistry				
Oil and Grease	EPA 1664A/9070	EPA 1664A/9071	-------	----------
Nitrocellulose	WS-WC-0050	WS-WC-0050	-------	----------
Perchlorate	EPA 6850	EPA 6850	-------	----------
Chloride	EPA 9056A/300.0	EPA 9056A/300.0	-------	----------
Fluoride	EPA 9056A/300.0	EPA 9056A/300.0	-------	----------
Sulfate	EPA 9056A/300.0	EPA 9056A/300.0	-------	----------
			-------	----------
Hazardous Waste Characteristics				
TCLP Extractables	----------	EPA 1311		
TCLP Inorganics	----------	EPA 1311	-------	----------
			-------	----------
Purgeable Organics				
(volatiles)				
Acetone	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Acrolein	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Acrylonitrile	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Allyl Chloride	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Benzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Bromochloromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Bromodichloromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Bromoform	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Bromomethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Carbon disulfide	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Carbon tetrachloride	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Chlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Chloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
2-Chloroethyl vinyl ether	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Chloroform	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Chloromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Chloroprene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Cyclohexane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1-Chlorocyclohexane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Dibromochloromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2-Dibromo-3-chloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2-Dibromoethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Dibromomethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,3-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,4-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
T-1,4-Dichloro-2-Butene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Dichlorodifluoromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1-Dichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2-Dichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
trans-1,2-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
cis-1,2-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,3-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
2,2-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
cis-1,3-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
trans-1,3-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,4-Dioxane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Ethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Ethylmethacrylate	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Hexachlorobutadiene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Hexane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
2-Hexanone (MBK)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Iodomethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Isobutanol	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Isopropyl Ether	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Methacrylonitrile	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Methyl tert-butyl ether (MTBE)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Methylene chloride	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Methyl ethyl ketone	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Methyl Methacrylate	EPA 8260B/8260C	EPA 8260B/8260C	-------	----------
4-Methyl-2-pentanone (MIBK)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Naphthalene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Propionitrile	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1,1,2-Tetrachloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1,2,2-Tetrachloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Tetrachloroethene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Tetrahydrofuran	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Toluene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2,3-Trichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2,4-Trichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1,1-Trichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1,2-Trichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,1-2-Trichloro-1,2-2-trifluorethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Trichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Trichlorofluoromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2,3-Trichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Vinyl acetate	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Vinyl chloride	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
m & p xylene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
o-xylene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Xylenes, Total	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
tert-amyl methyl ether (TAME)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
tert-butyl alcohol (TBA)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Ethyl tert-butyl ether (ETBE)	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Bromobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
n-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
sec-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
tert-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
2-Chlorotoluene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
4-Chlorotoluene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Isopropylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
n-Propylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Styrene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,2,4-Trimethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
1,3,5-Trimethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Oxygenates	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Gasoline Range Organics (GRO)	EPA 8260B/AK101	EPA 8260B/AK101	-------	EPA 5030A/5030B/5035/5035A
p-Isopropyltoluene	EPA 8260B/8260C	EPA 8260B/8260C	-------	EPA 5030A/5030B/5035/5035A
Extractable Organics				
(semivolatiles)				
Acenaphthene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Acenaphthylene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Acetophenone	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Acetylaminofluorene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Aminobiphenyl	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Aniline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Anthracene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
7,12-Dimethylbenz(a)anthracene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Aramite	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Benzaldehyde	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Dibenze(a,j)acridine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Benzidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Benzo(a)anthracene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzo(b)fluoranthene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzo(k)fluoranthene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzo(j)fluoranthene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Benzo(g,h,i)perylene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzo(a)pyrene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzo(e)pyrene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzoic acid	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Benzyl alcohol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Benzyl butyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-sec-Butyl-4,6-dinitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Bis(2-chloroethoxy) Methane	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Bis(2-chloroethyl) ether	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Bis(2-chloroisopropyl) ether	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Di(2-ethylhexyl) phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Bromophenyl phenyl ether	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Carbazole	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
4-Chloroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Chloro-3-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Hexacloropropene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Chloronaphthalene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Chlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Chlorophenyl phenyl ether	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Chrysene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Diallate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3510C/3550B/ 3580A
Dibenz(a,h)anthracene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Dibenzofuran	EPA 8270C/8270D	EPA 8270C/8270D	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
1,2-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,3-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,4-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
3,3'-Dichlorobenzidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,4-Dichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,6-Dichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Diethyl Phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,4-Dimethylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Dimethyl Phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Di-n-butyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Di-n-octyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4,6-Dinitro-2-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,4-Dinitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,4-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,6-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,4-Dioxane	WS-MS-0011	WS-MS-0011	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
1,2-Diphenylhydrazine (as Azobenzene)	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Famphur	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Fluoranthene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Fluorene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Hexachlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Hexachlorobutadiene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Hexachlorocyclopentadiene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Hexachloroethane	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Indeno(1,2,3-c,d)pyrene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Isodrin	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Isophorone	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Isosafrole	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Isosafrole #1	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Isosafrole #2	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Kepone	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Dimethoate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Methapyrilene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Methyl methanesulfonate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Methyl Parathion	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
3-Methylcholanthrene	EPA 8270C/8270D	EPA 8270C/8270D		EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Methylnaphthalene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
2-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
3-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
3&4-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Naphthalene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
1,4-Naphthoquinone	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1-Chloronaphthalene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1-Methylnaphthalene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1-Naphthylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Naphthylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
3-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Nitro-o-toluidine-1-oxide	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
5-Nitro-o-toluidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Nitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,2-Dinitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,3-Dinitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,4-Dinitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,3,5-Trinitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
4-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosodimethylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosodi-n-propylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosodiphenylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosodiethylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitroso-di-n-butylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosomethylethylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosomorpholine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosopyrrolidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
n-Nitrosopiperidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Parathion	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
p-Chorobenzilate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
p-Dimthylaminoazobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Pentachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Pentaclorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Pentacloronitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Pentacloroethane	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Phenacetin	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Phenanthrene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
a,a-Dimethylphenethlamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Phenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Biphenyl	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Diphenylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
p-Phenylenediamine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2-Picoline	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Phorate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Promamide	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Pyrene	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	EPA 8270C/8270D/WS-MS-006/WS-MS-0008	WS-MS-0006	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A Air: 3542/TO-13A
Pyridine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Safrole	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Sulfotepp	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Disulfotone	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Ethylmethanesulfonate	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Thionazin	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,2,4,5-Tetrachlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
1,2,4-Trichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
2,4,5-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,3,4,6-Tetrachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,3,5,6-Tetrachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
2,4,6-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Diesel Range Organics (DRO)	EPA 8015B/8015C/AK102	EPA 8015B/8015C/AK102	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Residual Range Organics	AK103	AK103	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
o,o,o-TEPT	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
o-Toluidine	EPA 8270C/8270D	EPA 8270C/8270D	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3580A
Dioxins				
2,3,7,8-TeCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B		----------
1,2,3,7,8-PeCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,4,7,8-HxCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,6,7,8-HxCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,7,8,9-HxCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,4,6,7,8-HpCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
OCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
2,3,7,8-TeCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,7,8-PeCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
2,3,4,7,8-PeCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,4,7,8-HxCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,6,7,8-HxCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,7,8,9-HxCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
2,3,4,6,7,8-HxCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,4,6,7,8-HpCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
1,2,3,4,7,8,9-HpCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
OCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total TCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Total PeCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total HxCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total HeptaCDD	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total TCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total PeCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total HxCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Total HpCDF	EPA 8280A/8280B/8290 /8290A/1613B	EPA 8280A/8280B/8290 /8290A/1613B	-------	----------
Chemical Warfare Degradates				
1,4-Dithiane	WS-MS-0003	WS-MS-0003	-------	----------
Benzothiazole	WS-MS-0003	WS-MS-0003	-------	----------
p-Chlorophenyl methylsulfide	WS-MS-0003	WS-MS-0003	-------	----------
p-Chlorophenyl methylsulfoxide	WS-MS-0003	WS-MS-0003	-------	----------
p-Chlorophenyl methylsulfone	WS-MS-0003	WS-MS-0003	-------	----------
Chloropicrin	WS-MS-0003	WS-MS-0003	-------	----------
Acetophenone	WS-MS-0003	WS-MS-0003	-------	----------
2-Chloroacetophenone	WS-MS-0003	WS-MS-0003	-------	----------
1,4-Oxathiane	WS-MS-0003	WS-MS-0003	-------	----------
Dimethyl Disulfide	WS-MS-0003	WS-MS-0003	-------	----------
Diisopropylmethylphosphate (DIMP)	WS-LC-0004	WS-LC-0004	-------	----------
Dimethylmethylphosphonate (DMMP)	WS-LC-0004	WS-LC-0004	-------	----------
Ethyl methylphosphonic acid (EMPA)	WS-LC-0004	WS-LC-0004	-------	----------
Isopropyl methylphosphonic acid (IMPA)	WS-LC-0004	WS-LC-0004	-------	----------
Methylphosphonic acid (MPA)	WS-LC-0004	WS-LC-0004	-------	----------
Thiodiglycol (2,2'-Thiodiethanol) (TDG)	WS-LC-0004	WS-LC-0004	-------	----------
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
4-Amino-2,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
3,5-Dinitroaniline	EPA 8330B	EPA 8330B	-------	----------
1,3-Dinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
2,4-Dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
2,6-Dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Ethylene glycol dinitrate	EPA 8330B	EPA 8330B	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Glycerol trinitrate (Nitroglycerin)	EPA 8330B	EPA 8330B	-------	----------
Hexahydro-1,3,5-trinitro-1,3,5-triazine (Hexogen)	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Methyl-2,4,6-trinitrophenylnitramine	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Nitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
2-Nitrotoluene (o-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
3-Nitrotoluene (m-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
4-Nitrotoluene (p-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Octahydro-1,3,5,7-tetranitro1,3,5,7-tetracine (Octogen)	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Picric acid	EPA 8330B	EPA 8330B	-------	----------
Pentaerythritol tetranitrate	EPA 8330B	EPA 8330B	-------	----------
1,3,5-Trinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
2,4,6-Trinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------	----------
Nitroguanidine	WS-LC-0010	WS-LC-0010	-------	----------
Nitrosamines				
N-Nitrosodimethylamine (NDMA)	WS-MS-0012	WS-MS-0012	-------	----------
Perfluoro Compounds				
Perfluorooctanoic acid	WS-LC-0020	WS-LC-0020	-------	----------
Perfluorooctane sulfonate	WS-LC-0020	WS-LC-0020	-------	----------
Pesticides/PCBs				
Aldrin	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
a-BHC	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
b-BHC	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
d-BHC	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
g-BHC (Lindane)	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
a-Chlordane	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
g-Chlordane	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Oxy-Chlordane	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
4,4'-DDD	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
2,4'-DDD	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
4,4'-DDE	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
2,4'-DDE	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
4,4'-DDT	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
2,4'-DDT	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Dieldrin	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endosulfan I	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endosulfan II	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endosulfan sulfate	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endrin	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endrin aldehyde	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Endrin ketone	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Heptachlor	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Heptachlor epoxide	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Hexachlorobenzene	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Methoxychlor	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Cis-Nonachlor	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Trans-Nonachlor	EPA 1699	EPA 1699		EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Toxaphene	EPA 8081A/8081B/EPA 1699	EPA 8081A/8081B/EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Mirex	EPA 1699	EPA 1699	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
Chlordane (technical)	EPA 8081A/8081B	EPA 8081A/8081B	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A
PCB (Aroclors)				
PCB-1016	EPA 8082/8082A	EPA 8082/8082A	-------	EPA 3500B/3500C/3510C/ 3550B/3550C/3620B/3660A/ 3620B/3665A
PCB-1221	EPA 8082/8082A	EPA 8082/8082A	-------	EPA 3500B/3500C/3510C/
PCB-1232	EPA 8082/8082A	EPA 8082/8082A	-------	3550B/3550C/3620B/3660A/
PCB-1242	EPA 8082/8082A	EPA 8082/8082A	-------	3620B/3665A
PCB-1248	EPA 8082/8082A	EPA 8082/8082A	-------	EPA 3500B/3500C/3510C/
PCB-1254	EPA 8082/8082A	EPA 8082/8082A	-------	3550B/3550C/3620B/3660A/
PCB-1260	EPA 8082/8082A	EPA 8082/8082A	-------	3620B/3665A

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB-1262	EPA 8082/8082A	EPA 8082/8082A	-------	EPA 3500B/3500C/3510C/
PCB-1268	EPA 8082/8082A	EPA 8082/8082A	-------	3550B/3550C/3620B/3660A/
PCB (congeners)				
PCB 1 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 2 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 3 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 4 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 5 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 6 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 7 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 8 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 9 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 10 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 11 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 12 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 13 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 14 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 15 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 16 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 17 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 18 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 19 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 20 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 21 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 22 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 23 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 24 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 25 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 26 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 27 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 28 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 29 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 30 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 32 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 31 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 33 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 34 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 35 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 36 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 37 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 38 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 39 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 40 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 41 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 42 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 43 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 44 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 45 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 46 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 47 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 48 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 49 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 50 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 51 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 52 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 53 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 54 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 55 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 56 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 57 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 58 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 59 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 60 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 61 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 62 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 63 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 64 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 65 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 66 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 67 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 68 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 69 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 70 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 71 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 72 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 73 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 74 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 75 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 76 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 77 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 78 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 79 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 80 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 81 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 82 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 83 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 84 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 85 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 86 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 87 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 88 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 89 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 90 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 91 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 92 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 93 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 94 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 95 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 96 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 97 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 98 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 99 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 100 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 101 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 102 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 103 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 104 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 105 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 106 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 108 (BZ)/107 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 109 (BZ)/108 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 107 (BZ)/109 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 110 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 111 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 112 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 113 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 114 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 115 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 116 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 117 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 118 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 119 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 120 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 121 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 122 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 123 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 124 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 125 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 126 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 127 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 128 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 129 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 130 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 131 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 132 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 133 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 134 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 135 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 136 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 137 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 138 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 139 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 140 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 141 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 142 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 143 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 144 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 145 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 146 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 147 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 148 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 149 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 150 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 151 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 152 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 153 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 154 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 155 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 156 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 157 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 158 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 159 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 160 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 161 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 162 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 163 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 164 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 165 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 166 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 167 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 168 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 169 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 170 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 171 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 172 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 173 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 174 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 175 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 176 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 177 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 178 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 179 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 180 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 181 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 182 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 183 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 184 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 185 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 186 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 187 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
PCB 188 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 189 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 190 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 191 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 192 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 193 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 194 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 195 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 196 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 197 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 198 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 201 (BZ)/199 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 199 (BZ)/200 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 200 (BZ)/201 (IUPAC)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 202 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 203 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 204 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 205 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 206 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 207 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 208 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
PCB 209 (BZ)	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------	----------
Hormones,Steroids, Pharmaceuticals and Disinfection Byproducts				
Acetominophen	WS-LC-0024	----------	-------	----------
Atenolol	WS-LC-0024	----------	-------	----------
Azithromycin	WS-LC-0024	----------		
Carbadox	WS-LC-0024	----------	-------	----------
Carbamazepine	WS-LC-0024	----------	-------	----------

Parameter/Analyte	Non potable Water	Solid Hazardous Waste	Air	Associated Prep Methods
Clarithromycin	WS-LC-0024	----------		
Diazepam	WS-LC-0024	----------	-------	----------
Digoxigenin	WS-LC-0024	----------	-------	----------
Digoxin	WS-LC-0024	----------		
Diphenylhydramine	WS-LC-0024	----------	-------	----------
Fluoxetine	WS-LC-0024	----------		
Flumequine	WS-LC-0024	----------	-------	----------
Gemfibrozil	WS-LC-0024	----------		
Ibuprofen	WS-LC-0024	----------	-------	----------
Naproxen	WS-LC-0024	----------	-------	----------
Ormetoprim	WS-LC-0024	----------	-------	----------
Penicillin G	WS-LC-0024	----------		
Sulfachloropyridazine	WS-LC-0024	----------	-------	----------
Sulfadiazine	WS-LC-0024	----------	-------	----------
Sulfamethizole	WS-LC-0024	----------	-------	----------
Sulfamethoxazole	WS-LC-0024	----------	-------	----------
Sulfathiazole	WS-LC-0024	----------	-------	----------
Thiabendazole	WS-LC-0024	----------		
Trimethoprim	WS-LC-0024	----------		
Tris (2-chloro-2-propyl)phosphate (TCPP)	WS-LC-0024	----------	-------	----------
Warfarin	WS-LC-0024	----------	-------	----------

The American Association for Laboratory Accreditation

World Class Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

TESTAMERICA LABORATORIES
WEST SACRAMENTO

West Sacramento, CA

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
CORPORATE SEAL 1978
DISTRICT OF COLUMBIA
A2LA

Presented this 27th day of March 2012.

President & CEO
For the Accreditation Council
Certificate Number 2928.01
Valid to January 31, 2014
Revised June 1, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

STATE OF KANSAS

DEPARTMENT OF HEALTH AND ENVIRONMENT

CERTIFICATE

This is to certify that Certificate No. E-10375

TestAmerica West Sacramento, Inc.
880 Riverside Parkway
West Sacramento, CA 95605-1500

has been accredited in accordance with K.S.A. 65-1,109a under the standards adopted in K.A.R. 28-15-36 for performing environmental analyses for the parameters listed on the attached form. Continuous accreditation depends on successful, ongoing participation in the program. Clients are urged to verify with this agency the laboratory's certification status for particular methods and analytes.

EFFECTIVE DATE: 11/01/2012 EXPIRATION DATE: 10/31/2013

Robert Moser MD
Secretary
Department of Health and Environment

Michelle L. Wade
Environmental Laboratory Certification Officers

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KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORY ACCREDITATION
RCRA PROGRAM - NON-POTABLE WATER AND SOLID/CHEMICAL WASTE MATRICES

This certificate supersedes all previous certificates

TestAmerica West Sacramento, Inc.
880 Riverside Parkway
West Sacramento, CA 95605-1500

Certificate Number: E-10375
Effective Date: 11/01/2012
Expiration Date: 10/31/2013
Reciprocity: FL & CA

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****CHARACTERISTICS**
Toxic-Characteristic-Leaching Procedure {EPA 1311}

****METALS**
Aluminum {EPA 6010}
Aluminum {EPA 6020}
Antimony {EPA 6010}
Antimony {EPA 6020}
Arsenic {EPA 6010}
Arsenic {EPA 6020}
Barium {EPA 6010}
Barium {EPA 6020}
Beryllium {EPA 6010}
Beryllium {EPA 6020}
Cadmium {EPA 6010}
Cadmium {EPA 6020}
Chromium {EPA 6010}
Chromium {EPA 6020}
Cobalt {EPA 6010}
Cobalt {EPA 6020}
Copper {EPA 6010}
Copper {EPA 6020}
Lead {EPA 6010}
Lead {EPA 6020}
Mercury {EPA 7470}
Mercury {EPA 7471}
Molybdenum {EPA 6010}
Nickel {EPA 6010}
Nickel {EPA 6020}
Selenium {EPA 6010}
Selenium {EPA 6020}
Silver {EPA 6010}
Silver {EPA 6020}
Sodium {EPA 6010}
Thallium {EPA 6010}
Thallium {EPA 6020}
Vanadium {EPA 6010}
Vanadium {EPA 6020}
Zinc {EPA 6010}

****ORGANIC CHEMISTRY (MEASUREMENT BY GC)**
{EPA 8081} 4,4'-DDD
{EPA 8081} 4,4'-DDE
{EPA 8081} 4,4'-DDT
{EPA 8081} Aldrin
{EPA 8081} alpha-BHC (alpha-Hexachlorocyclohexane)
{EPA 8081} alpha-Chlordane

{EPA 8081} beta-BHC (beta-Hexachlorocyclohexane)
{EPA 8081} Chlordane (Tech)
{EPA 8081} Chlorobenzilate
{EPA 8081} delta-BHC
{EPA 8081} Diallate
{EPA 8081} Dieldrin
{EPA 8081} Endosulfan I
{EPA 8081} Endosulfan II
{EPA 8081} Endosulfan Sulfate
{EPA 8081} Endrin
{EPA 8081} Endrin aldehyde
{EPA 8081} g-Chlordane
{EPA 8081} gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
{EPA 8081} Heptachlor
{EPA 8081} Heptachlor epoxide
{EPA 8081} Isodrin
{EPA 8081} Methoxychlor
{EPA 8081} Toxaphene
{EPA 8082} PCB-1016
{EPA 8082} PCB-1221
{EPA 8082} PCB-1232
{EPA 8082} PCB-1242
{EPA 8082} PCB-1248
{EPA 8082} PCB-1254
{EPA 8082} PCB-1260

**ORGANIC CHEMISTRY (MEASUREMENT BY GC/MS)
{EPA 8270} 1-Chloronaphthalene
{EPA 8270} 1-Naphthylamine
{EPA 8270} 1,2-Dichlorobenzene
{EPA 8270} 1,2-Diphenylhydrazine
{EPA 8270} 1,2,4-Trichlorobenzene
{EPA 8270} 1,2,4,5-Tetrachlorobenzene
{EPA 8270} 1,3-Dichlorobenzene
{EPA 8270} 1,3-Dinitrobenzene
{EPA 8270} 1,3,5-Trinitrobenzene
{EPA 8270} 1,4-Dichlorobenzene
{EPA 8270} 1,4-Dinitrobenzene
{EPA 8270} 1,4-Naphthoquinone
{EPA 8270} 1,4-Phenylenediamine
{EPA 8270} 2-Acetylaminofluorene
{EPA 8270} 2-Chloronaphthalene
{EPA 8270} 2-Chlorophenol
{EPA 8270} 2-Methyl-4,6-Dinitrophenol
{EPA 8270} 2-Methylnaphthalene
{EPA 8270} 2-Methylphenol (o-Cresol)
{EPA 8270} 2-Naphthylamine
{EPA 8270} 2-Nitroaniline
{EPA 8270} 2-Nitrophenol
{EPA 8270} 2-Picoline
{EPA 8270} 2,3,4,6-Tetrachlorophenol
{EPA 8270} 2,4-Dichlorophenol
{EPA 8270} 2,4-Dimethylphenol
{EPA 8270} 2,4-Dinitrophenol
{EPA 8270} 2,4,5-Trichlorophenol
{EPA 8270} 2,4,6-Trichlorophenol
{EPA 8270} 2,6-Dichlorophenol

{EPA 8270} 2,6-Dinitrotoluene
{EPA 8270} 3-Methylcholanthrene
{EPA 8270} 3-Methylphenol (m-Cresol)
{EPA 8270} 3-Nitroaniline
{EPA 8270} 3,3'-Dichlorobenzidine
{EPA 8270} 4-Aminobiphenyl
{EPA 8270} 4-Bromophenyl phenyl ether
{EPA 8270} 4-Chloro-3-methylphenol
{EPA 8270} 4-Chloroaniline
{EPA 8270} 4-Methylphenol (p-Cresol)
{EPA 8270} 4-Nitroaniline
{EPA 8270} 4-Nitrophenol
{EPA 8270} 5-Nitro-o-toluidine
{EPA 8270} 7,12-Dimethylbenz(a)anthracene
{EPA 8270} Acenaphthene
{EPA 8270} Acenaphthylene
{EPA 8270} Acetophenone
{EPA 8270} Aniline
{EPA 8270} Anthracene
{EPA 8270} Aramite
{EPA 8270} Benzidine
{EPA 8270} Benzoic acid
{EPA 8270} Benzo(a)anthracene
{EPA 8270} Benzo(a)pyrene
{EPA 8270} Benzo(b)fluoranthene
{EPA 8270} Benzo(g,h,i)perylene
{EPA 8270} Benzo(k)fluoranthene
{EPA 8270} Benzyl alcohol
{EPA 8270} Bis(2-chloroethoxy)methane
{EPA 8270} Bis(2-chloroethyl)ether
{EPA 8270} Bis(2-chloroisopropyl)ether
{EPA 8270} Bis(2-ethylhexyl)phthalate
{EPA 8270} Butyl benzyl phthalate
{EPA 8270} Chlorobenzilate
{EPA 8270} Chrysene
{EPA 8270} Di-n-butyl phthalate
{EPA 8270} Di-n-octyl phthalate
{EPA 8270} Diallate
{EPA 8270} Dibenzofuran
{EPA 8270} Dibenzo(a,h)anthracene
{EPA 8270} Dibenz(a,j)acridine
{EPA 8270} Diethyl phthalate
{EPA 8270} Dimethoate
{EPA 8270} Dimethyl phthalate
{EPA 8270} Diphenylamine
{EPA 8270} Ethyl methanesulfonate
{EPA 8270} Fluoranthene
{EPA 8270} Hexachlorobenzene
{EPA 8270} Hexachlorobutadiene
{EPA 8270} Hexachlorocyclopentadiene
{EPA 8270} Hexachloroethane
{EPA 8270} Hexachloropropene
{EPA 8270} Indeno(1,2,3-cd) pyrene
{EPA 8270} Isodrin
{EPA 8270} Isophorone
{EPA 8270} Isosafrole
{EPA 8270} Methylmethanesulfonate

{EPA 8270} N-nitroso-di-n-butylamine (NDBA)
{EPA 8270} N-nitroso-di-n-propylamine (NDPA)
{EPA 8270} N-nitrosodiethylamine (NDEA)
{EPA 8270} N-nitrosodimethylamine (NDMA)
{EPA 8270} N-Nitrosodiphenylamine
{EPA 8270} N-Nitrosomethylethylamine
{EPA 8270} N-Nitrosomorpholine
{EPA 8270} N-Nitrosopiperidine
{EPA 8270} N-Nitrosopyrrolidine
{EPA 8270} Naphthalene
{EPA 8270} Nitrobenzene
{EPA 8270} o-Toluidine
{EPA 8270} O,O,O-Triethylphosphorothioate
{EPA 8270} Parathion ethyl
{EPA 8270} Parathion methyl
{EPA 8270} Pentachlorobenzene
{EPA 8270} Pentachloronitrobenzene (PCNB)
{EPA 8270} Pentachlorophenol
{EPA 8270} Phenacetin
{EPA 8270} Phenanthrene
{EPA 8270} Phenol
{EPA 8270} Phorate
{EPA 8270} Pyrene
{EPA 8270} Pyridine
{EPA 8270} Safrole
{EPA 8280} 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
{EPA 8280} 1,2,3,4,6,7,8-Heptachlorodibenzofuran
{EPA 8280} 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)
{EPA 8280} 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
{EPA 8280} 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
{EPA 8280} 1,2,3,4,7,8-Hexachlorodibenzofuran
{EPA 8280} 1,2,3,4,7,8,9-Heptachlorodibenzofuran
{EPA 8280} 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
{EPA 8280} 1,2,3,6,7,8-Hexachlorodibenzofuran
{EPA 8280} 1,2,3,7,8-Pentachlorodibenzo-p-dioxin
{EPA 8280} 1,2,3,7,8-Pentachlorodibenzofuran
{EPA 8280} 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)
{EPA 8280} 1,2,3,7,8,9-Hexachlorodibenzofuran
{EPA 8280} 2,3,4,6,7,8-Hexachlorodibenzofuran
{EPA 8280} 2,3,4,7,8-Pentachlorodibenzofuran
{EPA 8280} 2,3,7,8-Tetrachlorodibenzo-p-dioxin
{EPA 8280} 2,3,7,8-Tetrachlorodibenzofuran
{EPA 8280} Total Heptachlorodibenzo-p-dioxin
{EPA 8280} Total Heptachlorodibenzofuran
{EPA 8280} Total Hexachlorodibenzo-p-dioxin
{EPA 8280} Total Hexachlorodibenzofuran
{EPA 8280} Total Pentachlorodibenzo-p-dioxin
{EPA 8280} Total Pentachlorodibenzofuran
{EPA 8280} Total Tetrachlorodibenzo-p-dioxin
{EPA 8280} Total Tetrachlorodibenzofuran
{EPA 8290} 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
{EPA 8290} 1,2,3,4,6,7,8-Heptachlorodibenzofuran
{EPA 8290} 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)
{EPA 8290} 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
{EPA 8290} 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
{EPA 8290} 1,2,3,4,7,8-Hexachlorodibenzofuran
{EPA 8290} 1,2,3,4,7,8,9-Heptachlorodibenzofuran

{EPA 8290} 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
{EPA 8290} 1,2,3,6,7,8-Hexachlorodibenzofuran
{EPA 8290} 1,2,3,7,8-Pentachlorodibenzo-p-dioxin
{EPA 8290} 1,2,3,7,8-Pentachlorodibenzofuran
{EPA 8290} 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)
{EPA 8290} 1,2,3,7,8,9-Hexachlorodibenzofuran
{EPA 8290} 2,3,4,6,7,8-Hexachlorodibenzofuran
{EPA 8290} 2,3,4,7,8-Pentachlorodibenzofuran
{EPA 8290} 2,3,7,8-Tetrachlorodibenzo-p-dioxin
{EPA 8290} 2,3,7,8-Tetrachlorodibenzofuran
{EPA 8290} Total Heptachlorodibenzo-p-dioxin
{EPA 8290} Total Heptachlorodibenzofuran
{EPA 8290} Total Hexachlorodibenzo-p-dioxin
{EPA 8290} Total Hexachlorodibenzofuran
{EPA 8290} Total Pentachlorodibenzo-p-dioxin
{EPA 8290} Total Pentachlorodibenzofurane
{EPA 8290} Total Tetrachlorodibenzo-p-dioxin
{EPA 8290} Total Tetrachlorodibenzofuran

**ORGANIC CHEMISTRY (MEASUREMENT BY HPLC)
{EPA 8330} 1,3-Dinitrobenzene
{EPA 8330} 1,3,5-Trinitrobenzene
{EPA 8330} 2-Amino-4,6-dinitrotoluene
{EPA 8330} 2-Nitrotoluene (ortho-Nitrotoluene)
{EPA 8330} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 8330} 2,4,6-Trinitrotoluene (TNT)
{EPA 8330} 2,6-Dinitrotoluene
{EPA 8330} 3-Nitrotoluene (meta-Nitrotoluene)
{EPA 8330} 4-Amino-2,6-dinitrotoluene
{EPA 8330} 4-Nitrotoluene (para-Nitrotoluene)
{EPA 8330} Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
{EPA 8330} Methyl-2,4,6-trinitrophenylnitramine
{EPA 8330} Nitrobenzene
{EPA 8330} Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)

End of Parameter List

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

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ENVIRONMENTAL

Valid To: October 31, 2013 Certificate Number: 2907.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Metals				
Aluminum	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Antimony	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Arsenic	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Barium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Beryllium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Boron	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C

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Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Cadmium	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Calcium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Chromium	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Cobalt	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Copper	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Iron	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Lead	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Lithium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Magnesium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Manganese	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Mercury	----------	----------	EPA 7470A	EPA 7471A / 7471B
Molybdenum	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nickel	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Potassium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Selenium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Silica	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Silicon	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Silver	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Sodium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Strontium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Thallium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Tin	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Titanium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Vanadium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Zinc	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nutrients				
Nitrate (as N)	----------	By calculation	By calculation / EPA 9056 / 9056A	By calculation / EPA 9056 / 9056A
Nitrate-nitrite (as N)	----------	EPA 353.2	EPA 353.2 / 9056 / 9056A	EPA 9056 / 9056A
Nitrite (as N)	----------	SM 4500-NO2 B	SM 4500-NO2 B; EPA 9056 / 9056A	EPA 9056 / 9056A
Orthophosphate (as P)	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Total phosphorus	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Demands		----------		
Total organic carbon	----------	----------	EPA 9060 / 9060A	EPA 9060 / 9060A
Total organic halides	----------	----------	EPA 9020B	----------
Wet Chemistry				----------
Alkalinity	----------	SM 2320 B	SM 2320 B	SM 2320 B
Ammonia	----------	EPA 350.1	EPA 350.1	----------
Biological Oxygen Demand	----------	SM 5210B	SM 5210B	----------
Bromide	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Total organic carbon	----------	----------	EPA 9060/9060A	EPA 9060 / 9060A
Chloride	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Chemical Oxygen Demand	----------	EPA 410.4	EPA 410.4	
Conductivity	----------	----------	EPA 9050 / 9050A	EPA 9050 / 9050A
Cyanide	----------	----------	EPA 9010B / 9012A / 9012B	EPA 9010B / 9012A / 9012B
Ferrous Iron	----------	SM 3500 Fe B, D	SM 3500 Fe B, D	
Fluoride	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Hexavalent Chromium	EPA 7196A	----------	EPA 7196A	EPA 7196A / 3060A
pH	----------	----------	EPA 9040B / 9045C	EPA 9040B / 9045C
Oil and Grease (HEM and SGT-HEM)	----------	----------	EPA 1664A	9071B
Percent moisture	----------	----------	----------	ASTM D2216
Perchlorate	----------	----------	EPA 6850 / 6860	EPA 6850 / 6860

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Phenols	----------	----------	EPA 9066	EPA 9066
Solids, Total	----------	SM 2540 B	SM 2540 B	SM 2540 B
Solids, Total Suspended	----------	SM 2540 D	SM 2540 D	SM 2540 D
Solids, Total Dissolved	----------	SM 2540 C	SM 2540 C	SM 2540 C
Sulfate	----------	----------	EPA 9038 / 9056 / 9056A	EPA 9038 / 9056 / 9056A
Sulfide, Total	----------	----------	EPA 9034	EPA 9034
Sulfide	----------	----------	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	----------	----------	EPA 351.2	----------
Purgeable Organics (volatiles)				----------
Acetone	----------	----------	EPA 8260B	EPA 8260B
Acetonitrile	----------	----------	EPA 8260B	EPA 8260B
Acrolein	----------	----------	EPA 8260B	EPA 8260B
Acrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Allyl Chloride	----------	----------	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether	EPA 8260B			
Benzene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B / AK101/ OK DEQ GRO
Bromobenzene	----------	----------	EPA 8260B	EPA 8260B
Bromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromodichloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromoform	----------	----------	EPA 8260B	EPA 8260B
Bromomethane	----------	----------	EPA 8260B	EPA 8260B
2-Butanone	----------	----------	EPA 8260B	EPA 8260B
n-Butyl alcohol	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
tert-Butyl alcohol	EPA 8260B			
n-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
Sec-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
Tert-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
Carbon disulfide	----------	----------	EPA 8260B	EPA 8260B
Carbon tetrachloride	----------	----------	EPA 8260B	EPA 8260B
Chlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
2-Chloro-1,3-butadiene	----------	----------	EPA 8260B	EPA 8260B
Chloroethane	----------	----------	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	----------	----------	EPA 8260B	EPA 8260B
Chloroform	----------	----------	EPA 8260B	EPA 8260B
1-Chlorohexane	----------	----------	EPA 8260B	EPA 8260B
Chloromethane	----------	----------	EPA 8260B	EPA 8260B
Chloroprene	----------	----------	EPA 8260B	EPA 8260B
3-Chloroprene	----------	----------	EPA 8260B	EPA 8260B
4-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
2-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
Cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Cyclohexanone	----------	----------	EPA 8260B	EPA 8260B
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
1,2-Dibromo-3-chloropropane (DBCP)	----------	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	----------	----------	EPA 8260B	EPA 8260B
Dibromomethane	----------	----------	EPA 8260B	EPA 8260B
1,2 Dibromoethane (EDB)	EPA 8011	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
1,2-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
1,3-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
1,4-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
cis-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
cis-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
Dichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
2,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
Diethyl ether	----------	----------	EPA 8260B	EPA 8260B
Di-isopropylether	EPA 8260B	----------	EPA 8260B	EPA 8260B
1,4-Dioxane	----------	----------	EPA 8260B / 8260B SIM	EPA 8260B / 8260B SIM
Ethanol	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Ethyl acetate	----------	----------	EPA 8260B	EPA 8260B
Ethyl benzene	EPA 8260B/8021B	----------	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B/ AK101/ OK DEQ GRO
Ethyl methacrylate	----------	----------	EPA 8260B	EPA 8260B
Ethyl tert-Butyl Ether	EPA 8260B			
Ethylene Glycol	----------	----------	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	EPA 8015C	----------	EPA 8015B / 8015C / AK101 / 8015D	EPA 8015B / 8015C / AK101 / 8015D
Hexane	----------	----------	EPA 8260B	EPA 8260B
2-Hexanone	----------	----------	EPA 8260B	EPA 8260B
Hexachlorobutadiene	----------	----------	EPA 8260B	EPA 8260B
Isobutyl alcohol (2-Methyl-1-propanol)	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Isopropyl alcohol	----------	----------	EPA 8260B	EPA 8260B
Isopropylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	----------	----------	EPA 8260B	EPA 8260B
Iodomethane	----------	----------	EPA 8260B	EPA 8260B
Methacrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Methanol	----------	----------	EPA 8015B / 8015C	EPA 8015B / 8015C
Methyl acetate	----------	----------	EPA 8260B	EPA 8260B
Methyl cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Methylene chloride	----------	----------	EPA 8260B	EPA 8260B
Methyl ethyle ketone (MEK)	----------	----------	EPA 8260B	EPA 8260B
Methyl isobutyl ketone	----------	----------	EPA 8260B	EPA 8260B
Methyl methacrylate	----------	----------	EPA 8260B	EPA 8260B
Methyl tert-butyl ether (MtBE)	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / OK DEQ GRO	EPA 8260B / 8021B/ OK DEQ GRO
4-Methyl-2-pentanone	----------	----------	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B / 8021B	----------	EPA 8260B/ OK DEQ GRO	EPA 8260B / OK DEQ GRO
2-Nitropropane	----------	----------	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	----------	----------	EPA 8015C	EPA 8015C
2-Pentanone	----------	----------	EPA 8260B	EPA 8260B
2-Propanol	----------	----------	EPA 8260B	EPA 8260B
Propionitrile	----------	----------	EPA 8260B	EPA 8260B
n-Propylbenzene	----------	----------	EPA 8260B	EPA 8260B
Propylene Glycol	----------	----------	EPA 8015C	EPA 8015C
Styrene	----------	----------	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
Tetrachloroethene	----------	----------	EPA 8260B	EPA 8260B
Tetrahydrofuran	----------	----------	EPA 8260B	EPA 8260B
Toluene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	----------	EPA 1664A	EPA 1664A	----------
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
Trichloroethene	----------	----------	EPA 8260B	EPA 8260B
Trichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	----------	EPA 504.1	EPA 504.1 / 8260B / 8011	EPA 8260B / 8011
1,1,2-Trichloro-1,2,2-trifluoroethane	----------	----------	EPA 8260B	EPA 8260B
Triethylene Glycol	----------	----------	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
1,3,5-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
Vinyl acetate	----------	----------	EPA 8260B	EPA 8260B
Vinyl chloride	----------	----------	EPA 8260B	EPA 8260B
Xylenes, total	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
1,2-Xylene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
M+P-Xylene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Methane	----------	----------	RSK-175	----------
Ethane	----------	----------	RSK-175	----------
Ethylene (Ethene)	----------	----------	RSK-175	----------
Acetylene	----------	----------	RSK-175	----------
Acetylene Ethane	----------	----------	RSK-175	----------
Extractable Organics (semivolatiles)				
Acenaphthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acenaphthylene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acetophenone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Acetylaminofluorene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Alachlor	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Aminobiphenyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Aniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Aramite	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Atrazine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Azobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzaldehyde	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzoic acid	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzo (a) anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Benzo (b) fluoranthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (k) fluoranthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (ghi) perylene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (a) pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzyl alcohol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethoxy) methane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethyl) ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroisopropyl) ether (2,2'Oxybis(1-chloropropane)	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-ethylhexyl) phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Bromophenyl phenyl ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Butyl benzyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-sec-Butyl-4,6-dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Carbazole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloroanilene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Chlorobenzilate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloro-3-methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Chloronaphthalene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chloronaphthalene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chlorophenyl phenyl ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Chrysene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Cresols	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diallate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dibenzo (a,h) anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Dibenzofuran	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
1,2-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3'-Dichlorobenzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diethyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethoate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3-Dimethylbenzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
p-Dimethylaminoazobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
7,12-Dimethylbenz(a)anthracene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Alpha-,alpha-Dimethylphenethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dimethylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-butyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-octyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrotoluene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dinitrotoluene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dioxane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diphenylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Diphenylhydrazine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Disulfoton	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Diesel Range Organics (DRO)	EPA 8015C	----------	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO
Ethyl methanesulfonate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Famphur	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Fluoroanthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Fluorene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Gasoline Range Organics	----------	----------	TX 1005 / OK DEQ GRO	TX 1005 / OK DEQ GRO
Hexachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorobutadiene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorocyclopentadiene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloroethane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloropropene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Indeno (1,2,3-cd) pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Isodrin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Isophorone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Isosafrole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Methapyrilene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Methylcholanthrene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methyl-4,6-Dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Methyl methane sulfonate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methylcholanthrene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Methylnaphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylnaphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3+4-Methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Naphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
1,4-Naphthoquinone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Naphthylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Naphthylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitroquinoline-1-oxide	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodimethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-butylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-propylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiphenylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomethylethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomorpholine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopiperidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopyrrolidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
5-Nitro-o-toluidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,2-oxybis(1-chloropropane)	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, methyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, ethyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Pentachloroethane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloronitobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorophenol	----------	----------	EPA 8270C / 8270D / 8321A / 8321B	EPA 8270C / 8270D / 8321A / 8321B
Phenacetin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Phenanthrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Phenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Phenylenediamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Phorate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Picoline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pronamide	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Pyridine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Safrole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Sulfotepp	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4,5-Tetrachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,3,4,6-Tetrachlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Thionazin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
o-Toluidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4-Trichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,5-Trichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,6-Trichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
o,o,o-Triethyl phosphorothioate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3,5-Trinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Tris(2,3-Dibromopropyl) phosphate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Motor Oil (Residual Range Organics)	----------	----------	EPA 8015B / 8015C, AK103 / OK DEQ RRO	EPA 8015B / 8015C, AK103 / OK DEQ RRO
Pesticides/Herbicides/PCBs				
Aldrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Atrazine	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos ethyl	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos methyl	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Beta-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
delta-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Gamma-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Bolstar	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Alpha-Chlordane	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Gamma-Chlordane	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Chlordane (technical)	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Chloropyrifos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Coumaphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4-D	----------	----------	EPA 8151A / 8321A	EPA 8151A /8321A
Dalapon	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
2,4-DB	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
4,4'-DDD	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDE	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4',-DDT	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Demeton-O	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton-S	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton, total	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Diazinon	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dicamba	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Dichlorovos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dichloroprop	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Dieldrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Dimethoate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dinoseb	----------	----------	EPA 8151A / 8321A	EPA 8321A
Disulfoton	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Endosulfan I	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endosulfan II	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endonsulfan sulfate	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin aldehyde	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin ketone	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
EPN	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethoprop	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethyl parathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Famphur	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Fensulfothion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Fenthion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Heptachlor	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Heptachlor epoxide	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Hexachlorobenzene	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Malathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
MCPA	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
MCPP	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Merphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Methoxychlor	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Methyl parathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Mevinphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Naled	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
PCB-1016 (Arochlor)	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1221	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1232	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1242	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1248	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1254	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1260	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1262	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1268	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
Phorate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Phosmet	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Propazine	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Ronnel	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Simazine	----------	----------	EPA 8081A / 8081B / 8141A / 8141B	EPA 8081A / 8081B / 8141A / 8141B
Stirophos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Sulfotepp	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-T	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Thionazin	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Tokuthion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-TP	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Toxaphene	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Trichloronate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
o,o,o-triethylphos phorothioate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Explosives				
1,3,5-Trinitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
1,3-Dinitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,4,6-Trinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3,5-Dinitroaniline	----------	----------	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,6-Dinitroltoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Amino-4,6-dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Amino-2,6-dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitroglycerin	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Octahydro-1,3,5,7-tetrabitro-1,3,5,7-tetrazocine (HMX)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Pentaerythritoltetranitrate (PETN)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Picric acid	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Tetryl (methyl2,4,6-trinitrophenylnitramine	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Hydrazines				
Hydrazine	----------	SOP DV WC-0077	SOP DV WC-0077	SOP DV WC-0077
Monomethyl hydrazine	----------	SOP DV WC-0077	SOP DV WC-0077	SOP DV WC-0077
1,1-Dimethylhydrazine	----------	SOP DV WC-0077	SOP DV WC-0077	SOP DV WC-0077
Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Sulfonates (PFSs)				
Perfluorobutanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoropentanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroheptanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorononanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroundecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorododecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotridecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotetradecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorobutane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonamide	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
N-Nitrosodimethylamine (NDMA)	----------	SOP DV-LC-0019	SOP DV-LC-0019	SOP DV-LC-0019
Hazardous Waste Characteristics				
Conductivity	----------	----------	EPA 9050A	EPA 9050A
Corrosivity	----------	----------	EPA 9040B	9045C
Ignitibility	----------	EPA 1010/EPA 1010A	EPA 1010 / 1010A	EPA 1010 / 1010A
Paint Filter Liquids Test	----------	----------	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	----------	----------	EPA 1312	EPA 1312
ToxicityCharacteristic Leaching Procedure	----------	----------	EPA 1311	EPA 1311
Organic Prep Methods				
Separatory Funnel Liquid-Liquid Extraction	----------	----------	EPA 3510C	----------

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Continuous Liquid-Liquid Extraction	----------	----------	EPA 3520C	----------
Soxhlet Extraction	----------	----------	----------	EPA 3540C
Large Volume Injection (Micro-extraction)	----------	----------	EPA 3511	----------
Microwave Extraction	----------	----------	----------	EPA 3546
Ultrasonic Extraction	----------	----------	----------	EPA 3550B
Ultrasonic Extraction	----------	----------	----------	EPA 3550C
Waste Dilution	----------	----------	EPA 3580A	EPA 3580A
Solid Phase Extraction Volatiles Purge and trap Volatiles purge and trap for soils	----------	----------	EPA 3535A EPA 5030B	EPA 5030B EPA 5035
Organic Cleanup Procedures				
Florisil Cleanup	----------	----------	EPA 3620B	EPA 3620B
Florisil Cleanup	----------	----------	EPA 3620C	EPA 3620C
Sulfur Cleanup	----------	----------	EPA 3660B	EPA 3660B
Sulfuric Acid/Permanganate Cleanup	----------	----------	EPA 3665A	EPA 3665A
Metals Digestion				
Acid Digestion Total Recoverable or Dissolved Metals	----------	----------	EPA 3005A	----------
Acid Digestion for Total Metals	----------	----------	EPA 3010A	----------
Acid Digestion for Total Metals	----------	----------	EPA 3020A	----------
Acid Digestion of Sediments, Sludges and Soils	----------	----------	----------	EPA 3050B

The American Association for Laboratory Accreditation

World Class Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

TESTAMERICA DENVER

Arvada, CO

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 5th day of October 2011.

President & CEO
For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2013
Revised June 1, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

STATE OF KANSAS

DEPARTMENT OF HEALTH AND ENVIRONMENT

CERTIFICATE

This is to certify that Certificate No. E-10166

TestAmerica Denver, Inc.
4955 Yarrow Street
Arvada, CO 80002

has been accredited in accordance with K.S.A. 65-1,109a under the standards adopted in K.A.R. 28-15-36 for performing environmental analyses for the parameters listed on the attached form. Continuous accreditation depends on successful, ongoing participation in the program. Clients are urged to verify with this agency the laboratory's certification status for particular methods and analytes.

EFFECTIVE DATE: 05/01/2012 EXPIRATION DATE: 04/30/2013

Robert Moser

Secretary
Department of Health and Environment

Michelle L. Wade

Environmental Laboratory Certification Officers

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KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORY ACCREDITATION
SAFE DRINKING WATER ACT PROGRAM - DRINKING WATER MATRIX

This certificate supersedes all previous certificates

TestAmerica Denver, Inc.
4955 Yarrow Street
Arvada, CO 80002

Certificate Number: E-10166
Effective Date: 05/01/2012
Expiration Date: 04/30/2013
Reciprocity: FL

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****METALS**
Aluminum {EPA 200.7}
Antimony {EPA 200.8}
Arsenic {EPA 200.8}
Barium {EPA 200.7}
Barium {EPA 200.8}
Beryllium {EPA 200.7}
Beryllium {EPA 200.8}
Cadmium {EPA 200.7}
Cadmium {EPA 200.8}
Calcium {EPA 200.7}
Chromium {EPA 200.7}
Chromium {EPA 200.8}
Copper {EPA 200.7}
Copper {EPA 200.8}
Iron {EPA 200.7}
Lead {EPA 200.8}
Magnesium {EPA 200.7}
Manganese {EPA 200.7}
Manganese {EPA 200.8}
Mercury {EPA 245.1}
Nickel {EPA 200.7}
Nickel {EPA 200.8}
Selenium {EPA 200.8}
Silica {EPA 200.7}
Silver {EPA 200.7}
Silver {EPA 200.8}
Sodium {EPA 200.7}
Thallium {EPA 200.8}
Zinc {EPA 200.7}
Zinc {EPA 200.8}

****MICROBIOLOGY - Filtration**
Fecal Coliforms {SM 9222 D (MF)}
Total Coliforms {SM 9222 A,B,C (MF)}

****MINERALS**
Alkalinity {SM 2320 B}
Bromide {EPA 300.0}
Chloride {EPA 300.0}
Fluoride {EPA 300.0}
Hardness {SM 2340 B}
Sulfate {ASTM D516-90, 02}
Sulfate {EPA 300.0}

****MISCELLANEOUS**
Color {SM 2120 B}
Conductivity {SM 2510 B}
Hydrogen Ion (pH) {EPA 150.1}
Hydrogen Ion (pH) {SM 4500-H B}
Ortho-phosphate {EPA 365.1}

**NUTRIENTS
Nitrate {EPA 300.0}
Nitrate {EPA 353.2}
Nitrite {EPA 300.0}
Nitrite {SM 4500-NO2 B}

**ORGANIC CHEMISTRY DBCP/EDB
{EPA 504.1} Dibromochloropropane (DBCP)
{EPA 504.1} Ethylene dibromide (EDB, 1,2-Dibromoethane)

**RESIDUES
Residue, Filterable (TDS) {SM 2540C}

End of Parameter List

ENVIRONMENTAL LABORATORY ACCREDITATION

RCRA PROGRAM - NON-POTABLE WATER AND SOLID/CHEMICAL WASTE MATRICES

This certificate supersedes all previous certificates

TestAmerica Denver, Inc.
4955 Yarrow Street
Arvada, CO 80002

Certificate Number: E-10166
Effective Date: 05/01/2012
Expiration Date: 04/30/2013
Reciprocity: FL

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****CHARACTERISTICS**
Ignitability {EPA 1010}
Synthetic-Precipitation Leaching Procedure {EPA 1312}
Toxic-Characteristic-Leaching Procedure {EPA 1311}

****DEMANDS**
Total Organic Carbon {EPA 9060}

****METALS**
Aluminum {EPA 6010}
Antimony {EPA 6010}
Antimony {EPA 6020}
Arsenic {EPA 6010}
Arsenic {EPA 6020}
Barium {EPA 6010}
Barium {EPA 6020}
Beryllium {EPA 6010}
Beryllium {EPA 6020}
Boron {EPA 6010}
Cadmium {EPA 6010}
Cadmium {EPA 6020}
Calcium {EPA 6010}
Chromium {EPA 6010}
Chromium {EPA 6020}
Chromium, VI {EPA 7196}
Cobalt {EPA 6010}
Cobalt {EPA 6020}
Copper {EPA 6010}
Copper {EPA 6020}
Iron {EPA 6010}
Lead {EPA 6010}
Lead {EPA 6020}
Lithium {EPA 6010}
Magnesium {EPA 6010}
Manganese {EPA 6010}
Manganese {EPA 6020}
Mercury {EPA 7470}
Mercury {EPA 7471}
Molybdenum {EPA 6010}
Nickel {EPA 6010}
Nickel {EPA 6020}
Phosphorus {EPA 6010}
Potassium {EPA 6010}
Selenium {EPA 6010}
Selenium {EPA 6020}
Silica {EPA 6010}
Silver {EPA 6010}
Silver {EPA 6020}
Sodium {EPA 6010}
Strontium {EPA 6010}

Thallium {EPA 6020}
Tin {EPA 6010}
Titanium {EPA 6010}
Vanadium {EPA 6010}
Vanadium {EPA 6020}
Zinc {EPA 6010}
Zinc {EPA 6020}

**MINERALS
Bromide {EPA 9056}
Chloride {EPA 9056}
Fluoride {EPA 9056}
Sulfate {EPA 9038}
Sulfate {EPA 9056}
Sulfide {EPA 9030}
Sulfide {EPA 9034}

**MISCELLANEOUS
Conductivity {EPA 9050}
Cyanide {EPA 9010}
Cyanide {EPA 9012}
Hydrogen Ion (pH) {EPA 9040}
Hydrogen Ion (pH) {EPA 9045}
Oil & Grease {EPA 9071}
Paint Filter Liquids Test {EPA 9095}
Phenolics {EPA 9066}
Total Organic-Halides {EPA 9020}

**NUTRIENTS
Nitrate {EPA 9056}
Nitrite {EPA 9056}
Ortho-phosphate {EPA 9056}

**ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC)
{EPA 8015} Ethanol
{EPA 8015} Isobutyl Alcohol
{EPA 8015} Methanol
{EPA 8015} n-Butyl alcohol
{EPA 8021} 1,2-Dichlorobenzene
{EPA 8021} 1,3-Dichlorobenzene
{EPA 8021} 1,4-Dichlorobenzene
{EPA 8021} Benzene
{EPA 8021} Chlorobenzene
{EPA 8021} Ethylbenzene
{EPA 8021} meta-Xylene
{EPA 8021} Naphthalene
{EPA 8021} ortho-Xylene
{EPA 8021} para-Xylene
{EPA 8021} Toluene

**ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC/MS)
{EPA 8260} 1,1-Dichloroethane
{EPA 8260} 1,1-Dichloroethene
{EPA 8260} 1,1-Dichloropropene
{EPA 8260} 1,1,1-Trichloroethane
{EPA 8260} 1,1,1,2-Tetrachloroethane
{EPA 8260} 1,1,2-Trichloroethane
{EPA 8260} 1,1,2,2-Tetrachloroethane
{EPA 8260} 1,2-Dichlorobenzene
{EPA 8260} 1,2-Dichloroethane
{EPA 8260} 1,2-Dichloropropane

{EPA 8260} 1,2,3-Trichlorobenzene
{EPA 8260} 1,2,3-Trichloropropane
{EPA 8260} 1,2,4-Trichlorobenzene
{EPA 8260} 1,2,4-Trimethylbenzene
{EPA 8260} 1,3-Dichlorobenzene
{EPA 8260} 1,3-Dichloropropane
{EPA 8260} 1,3,5-Trimethylbenzene
{EPA 8260} 1,4-Dichlorobenzene
{EPA 8260} 1,4-Dioxane
{EPA 8260} 2-Chloroethyl vinyl ether
{EPA 8260} 2-Chlorotoluene
{EPA 8260} 2-Hexanone
{EPA 8260} 2-Nitropropane
{EPA 8260} 2-Pentanone
{EPA 8260} 2-Propanol
{EPA 8260} 2,2-Dichloropropane
{EPA 8260} 4-Chlorotoluene
{EPA 8260} 4-Methyl-2-Pentanone (MIBK)
{EPA 8260} Acetone
{EPA 8260} Acetonitrile
{EPA 8260} Acrolein
{EPA 8260} Acrylonitrile
{EPA 8260} Allyl Chloride
{EPA 8260} Benzene
{EPA 8260} Bromobenzene
{EPA 8260} Bromochloromethane
{EPA 8260} Bromodichloromethane
{EPA 8260} Bromoform
{EPA 8260} Bromomethane (Methyl bromide)
{EPA 8260} Carbon disulfide
{EPA 8260} Carbon tetrachloride
{EPA 8260} Chlorobenzene
{EPA 8260} Chloroethane
{EPA 8260} Chloroform
{EPA 8260} Chloromethane (Methyl chloride)
{EPA 8260} cis-1,2-Dichloroethylene
{EPA 8260} cis-1,3-Dichloropropene
{EPA 8260} cis-1,4-Dichloro-2-butene
{EPA 8260} Dibromochloromethane
{EPA 8260} Dibromochloropropane (DBCP)
{EPA 8260} Dibromomethane
{EPA 8260} Dichlorodifluoromethane
{EPA 8260} Dichloromethane (Methylene chloride)
{EPA 8260} Diethyl ether
{EPA 8260} Ethanol
{EPA 8260} Ethyl acetate
{EPA 8260} Ethyl methacrylate
{EPA 8260} Ethylbenzene
{EPA 8260} Ethylene dibromide (EDB, 1,2-Dibromoethane)
{EPA 8260} Ethylene oxide
{EPA 8260} Hexachlorobutadiene
{EPA 8260} Iodomethane
{EPA 8260} Isobutyl Alcohol
{EPA 8260} Isopropylbenzene
{EPA 8260} meta-Xylene
{EPA 8260} Methacrylonitrile
{EPA 8260} Methyl ethyl ketone
{EPA 8260} Methyl tert-butyl ether (MTBE)
{EPA 8260} Methylmethacrylate
{EPA 8260} n-Butyl alcohol
{EPA 8260} n-Butylbenzene

NELAP RECOGNIZED
TNI
ACCREDITATION BODY

{EPA 8260} n-Propylbenzene
{EPA 8260} Naphthalene
{EPA 8260} ortho-Xylene
{EPA 8260} para-Xylene
{EPA 8260} Propionitrile
{EPA 8260} sec-Butylbenzene
{EPA 8260} Styrene
{EPA 8260} t-Butyl alcohol
{EPA 8260} tert-Butylbenzene
{EPA 8260} Tetrachloroethene (Perchloroethylene)
{EPA 8260} Toluene
{EPA 8260} trans-1,2-Dichloroethylene
{EPA 8260} trans-1,3-Dichloropropene
{EPA 8260} trans-1,4-Dichloro-2-butene
{EPA 8260} Trichloroethene (Trichloroethylene)
{EPA 8260} Trichlorofluoromethane
{EPA 8260} Vinyl Acetate
{EPA 8260} Vinyl chloride

**ORGANIC CHEMISTRY (MEASUREMENT BY GC)
{EPA 8011} Dibromochloropropane (DBCP)
{EPA 8011} Ethylene dibromide (EDB, 1,2-Dibromoethane)
{EPA 8081} 4,4'-DDD
{EPA 8081} 4,4'-DDE
{EPA 8081} 4,4'-DDT
{EPA 8081} Aldrin
{EPA 8081} alpha-BHC (alpha-Hexachlorocyclohexane)
{EPA 8081} alpha-Chlordane
{EPA 8081} beta-BHC (beta-Hexachlorocyclohexane)
{EPA 8081} Chlordane (Tech)
{EPA 8081} Chlorobenzilate
{EPA 8081} delta-BHC
{EPA 8081} Diallate
{EPA 8081} Dicofol
{EPA 8081} Dieldrin
{EPA 8081} Endosulfan I
{EPA 8081} Endosulfan II
{EPA 8081} Endosulfan Sulfate
{EPA 8081} Endrin
{EPA 8081} Endrin aldehyde
{EPA 8081} Endrin ketone
{EPA 8081} g-Chlordane
{EPA 8081} gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
{EPA 8081} Heptachlor
{EPA 8081} Heptachlor epoxide
{EPA 8081} Hexachlorobenzene
{EPA 8081} Isodrin
{EPA 8081} Methoxychlor
{EPA 8081} Mirex
{EPA 8081} Toxaphene
{EPA 8082} PCB-1016
{EPA 8082} PCB-1221
{EPA 8082} PCB-1232
{EPA 8082} PCB-1242
{EPA 8082} PCB-1248
{EPA 8082} PCB-1254
{EPA 8082} PCB-1260
{EPA 8141} Atrazine
{EPA 8141} Azinphos-ethyl (Ethyl guthion)
{EPA 8141} Azinphos-methyl (Guthion)
{EPA 8141} Bolstar (Sulprofos)

{EPA 8141} Carbophenothion
{EPA 8141} Chlorpyrifos
{EPA 8141} Chlorpyrifos methyl
{EPA 8141} Coumaphos
{EPA 8141} Demeton-o
{EPA 8141} Demeton-s
{EPA 8141} Diazinon
{EPA 8141} Dichlorovos (DDVP, Dichlorvos)
{EPA 8141} Dimethoate
{EPA 8141} Disulfoton
{EPA 8141} EPN
{EPA 8141} Ethoprop
{EPA 8141} Famphur
{EPA 8141} Fensulfothion
{EPA 8141} Fenthion
{EPA 8141} Malathion
{EPA 8141} Merphos
{EPA 8141} Mevinphos
{EPA 8141} Naled
{EPA 8141} Parathion ethyl
{EPA 8141} Parathion methyl
{EPA 8141} Phorate
{EPA 8141} Phosmet (Imidan)
{EPA 8141} Ronnel
{EPA 8141} Simazine
{EPA 8141} Stirophos
{EPA 8141} Tetraethyl dithiopyrophosphate (Sulfotepp)
{EPA 8141} Thionazine
{EPA 8141} Tokuthion
{EPA 8141} Trichloronate
{EPA 8151} 2,4-D
{EPA 8151} 2,4-DB
{EPA 8151} 2,4,5-T
{EPA 8151} 2,4,5-TP (Silvex)
{EPA 8151} Dalapon
{EPA 8151} Dicamba
{EPA 8151} Dichlorprop
{EPA 8151} Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
{EPA 8151} MCPA
{EPA 8151} MCPP
{EPA 8151} Picloram

**ORGANIC CHEMISTRY (MEASUREMENT BY GC/MS)
{EPA 8270} 1-Chloronaphthalene
{EPA 8270} 1-Naphthylamine
{EPA 8270} 1,2-Dichlorobenzene
{EPA 8270} 1,2-Diphenylhydrazine
{EPA 8270} 1,2,4-Trichlorobenzene
{EPA 8270} 1,2,4,5-Tetrachlorobenzene
{EPA 8270} 1,3-Dichlorobenzene
{EPA 8270} 1,3-Dinitrobenzene
{EPA 8270} 1,3,5-Trinitrobenzene
{EPA 8270} 1,4-Dichlorobenzene
{EPA 8270} 1,4-Dinitrobenzene
{EPA 8270} 1,4-Naphthoquinone
{EPA 8270} 1,4-Phenylenediamine
{EPA 8270} 2-Acetylaminofluorene
{EPA 8270} 2-Chloronaphthalene
{EPA 8270} 2-Chlorophenol
{EPA 8270} 2-Methyl-4,6-Dinitrophenol
{EPA 8270} 2-Methylnaphthalene

{EPA 8270} 2-Methylphenol (o-Cresol)
{EPA 8270} 2-Naphthylamine
{EPA 8270} 2-Nitroaniline
{EPA 8270} 2-Nitrophenol
{EPA 8270} 2-Picoline
{EPA 8270} 2,3,4,6-Tetrachlorophenol
{EPA 8270} 2,4-Dichlorophenol
{EPA 8270} 2,4-Dimethylphenol
{EPA 8270} 2,4-Dinitrophenol
{EPA 8270} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 8270} 2,4,5-Trichlorophenol
{EPA 8270} 2,4,6-Trichlorophenol
{EPA 8270} 2,6-Dichlorophenol
{EPA 8270} 2,6-Dinitrotoluene
{EPA 8270} 3-Methylcholanthrene
{EPA 8270} 3-Methylphenol (m-Cresol)
{EPA 8270} 3-Nitroaniline
{EPA 8270} 3,3'-Dichlorobenzidine
{EPA 8270} 3,3'-Dimethylbenzidine
{EPA 8270} 4-Aminobiphenyl
{EPA 8270} 4-Bromophenyl phenyl ether
{EPA 8270} 4-Chloro-3-methylphenol
{EPA 8270} 4-Chloroaniline
{EPA 8270} 4-Chlorophenyl phenyl ether
{EPA 8270} 4-Methylphenol (p-Cresol)
{EPA 8270} 4-Nitroaniline
{EPA 8270} 4-Nitrophenol
{EPA 8270} 4,4'-Methylenebis(2-chloroaniline)
{EPA 8270} 5-Nitro-o-toluidine
{EPA 8270} 7,12-Dimethylbenz(a)anthracene
{EPA 8270} Acenaphthene
{EPA 8270} Acenaphthylene
{EPA 8270} Acetophenone
{EPA 8270} alpha-alpha-Dimethylphenethylamine
{EPA 8270} Aniline
{EPA 8270} Anthracene
{EPA 8270} Aramite
{EPA 8270} Benzidine
{EPA 8270} Benzo(a)anthracene
{EPA 8270} Benzo(a)pyrene
{EPA 8270} Benzo(b)fluoranthene
{EPA 8270} Benzo(g,h,i)perylene
{EPA 8270} Benzo(k)fluoranthene
{EPA 8270} Benzyl alcohol
{EPA 8270} Bis(2-chloroethoxy)methane
{EPA 8270} Bis(2-chloroethyl)ether
{EPA 8270} Bis(2-chloroisopropyl)ether
{EPA 8270} Bis(2-ethylhexyl)phthalate
{EPA 8270} Butyl benzyl phthalate
{EPA 8270} Chlorobenzilate
{EPA 8270} Chrysene
{EPA 8270} Di-n-butyl phthalate
{EPA 8270} Diallate
{EPA 8270} Dibenzo(a,h)anthracene
{EPA 8270} Dibenz(a,j)acridine
{EPA 8270} Diethyl phthalate
{EPA 8270} Dimethoate
{EPA 8270} Dimethyl phthalate
{EPA 8270} Disulfoton
{EPA 8270} Ethyl methanesulfonate
{EPA 8270} Famphur

ELAP RECOGNIZED
TNI
ACCREDITATION BODY

{EPA 8270} Fluoranthene
{EPA 8270} Fluorene
{EPA 8270} Hexachlorobenzene
{EPA 8270} Hexachlorobutadiene
{EPA 8270} Hexachlorocyclopentadiene
{EPA 8270} Hexachloroethane
{EPA 8270} Hexachloropropene
{EPA 8270} Indeno(1,2,3-cd) pyrene
{EPA 8270} Isodrin
{EPA 8270} Isophorone
{EPA 8270} Isosafrole
{EPA 8270} Methapyrilene
{EPA 8270} Methylmethanesulfonate
{EPA 8270} N-nitroso-di-n-butylamine (NDBA)
{EPA 8270} N-nitroso-di-n-propylamine (NDPA)
{EPA 8270} N-nitrosodiethylamine (NDEA)
{EPA 8270} N-nitrosodimethylamine (NDMA)
{EPA 8270} N-Nitrosodiphenylamine
{EPA 8270} N-Nitrosomethylethylamine
{EPA 8270} N-Nitrosomorpholine
{EPA 8270} N-Nitrosopiperidine
{EPA 8270} N-Nitrosopyrrolidine
{EPA 8270} O,O,O-Triethylphosphorothioate
{EPA 8270} Parathion ethyl
{EPA 8270} Parathion methyl
{EPA 8270} Pentachlorobenzene
{EPA 8270} Pentachloronitrobenzene (PCNB)
{EPA 8270} Pentachlorophenol
{EPA 8270} Phenacetin
{EPA 8270} Phenanthrene
{EPA 8270} Phenol
{EPA 8270} Phorate
{EPA 8270} Phthalic anhydride
{EPA 8270} Pyrene
{EPA 8270} Pyridine
{EPA 8270} Safrole
{EPA 8270} Tetraethyl dithiopyrophosphate (Sulfotepp)
{EPA 8270} Thionazine
{EPA 8270} Tris(2,3-dibromopropyl)phosphate

**ORGANIC CHEMISTRY (MEASUREMENT BY HPLC)
{EPA 8310} Acenaphthene
{EPA 8310} Acenaphthylene
{EPA 8310} Anthracene
{EPA 8310} Benzo(a)anthracene
{EPA 8310} Benzo(a)pyrene
{EPA 8310} Benzo(b)fluoranthene
{EPA 8310} Benzo(g,h,i)perylene
{EPA 8310} Benzo(k)fluoranthene
{EPA 8310} Chrysene
{EPA 8310} Dibenzo(a,h)anthracene
{EPA 8310} Fluoranthene
{EPA 8310} Fluorene
{EPA 8310} Indeno(1,2,3-cd) pyrene
{EPA 8310} Naphthalene
{EPA 8310} Phenanthrene
{EPA 8310} Pyrene
{EPA 8330} 1,3-Dinitrobenzene
{EPA 8330} 1,3,5-Trinitrobenzene
{EPA 8330} 2-Amino-4,6-dinitrotoluene
{EPA 8330} 2-Nitrotoluene (ortho-Nitrotoluene)

NELAP RECOGNIZED
TNI
ACCREDITATION BODY

{EPA 8330} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 8330} 2,4,6-Trinitrotoluene (TNT)
{EPA 8330} 2,6-Dinitrotoluene
{EPA 8330} 3-Nitrotoluene (meta-Nitrotoluene)
{EPA 8330} 4-Amino-2,6-dinitrotoluene
{EPA 8330} 4-Nitrotoluene (para-Nitrotoluene)
{EPA 8330} Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
{EPA 8330} Methyl-2,4,6-trinitrophenylnitramine
{EPA 8330} Nitrobenzene
{EPA 8330} Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)

****TOTAL PETROLEUM HYDROCARBONS**
{EPA 8015} DRO
{EPA 8015} GRO

End of Parameter List

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORY ACCREDITATION
CLEAN WATER ACT PROGRAM - NON-POTABLE WATER MATRIX

This certificate supersedes all previous certificates

TestAmerica Denver, Inc.
4955 Yarrow Street
Arvada, CO 80002

Certificate Number: E-10166
Effective Date: 05/01/2012
Expiration Date: 04/30/2013
Reciprocity: FL

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****DEMANDS**
BOD {SM 5210 B}
cBOD {SM 5210 B}
COD {EPA 410.4}
Total Organic Carbon {SM 5310 B, C, or D}

****METALS**
Aluminum {EPA 200.7}
Antimony {EPA 200.7}
Antimony {EPA 200.8}
Arsenic {EPA 200.7}
Arsenic {EPA 200.8}
Barium {EPA 200.7}
Barium {EPA 200.8}
Beryllium {EPA 200.7}
Beryllium {EPA 200.8}
Boron {EPA 200.7}
Cadmium {EPA 200.7}
Cadmium {EPA 200.8}
Calcium {EPA 200.7}
Chromium {EPA 200.7}
Chromium {EPA 200.8}
Chromium, VI {SM 3500-Cr B}
Cobalt {EPA 200.7}
Cobalt {EPA 200.8}
Copper {EPA 200.7}
Copper {EPA 200.8}
Iron {EPA 200.7}
Lead {EPA 200.7}
Lead {EPA 200.8}
Magnesium {EPA 200.7}
Manganese {EPA 200.7}
Manganese {EPA 200.8}
Mercury {EPA 245.1}
Molybdenum {EPA 200.7}
Molybdenum {EPA 200.8}
Nickel {EPA 200.7}
Nickel {EPA 200.8}
Potassium {EPA 200.7}
Selenium {EPA 200.7}
Selenium {EPA 200.8}
Silica, Dissolved {EPA 200.7}
Silver {EPA 200.7}
Silver {EPA 200.8}
Sodium {EPA 200.7}
Thallium {EPA 200.7}
Thallium {EPA 200.8}
Tin {EPA 200.7}
Titanium {EPA 200.7}
Vanadium {EPA 200.7}
Vanadium {EPA 200.8}

NELAP RECOGNIZED
ACCREDITATION BODY

Zinc {EPA 200.7}
Zinc {EPA 200.8}

**METALS - 503 Regs
Arsenic {EPA 6010}
Arsenic {EPA 6020}
Cadmium {EPA 6010}
Cadmium {EPA 6020}
Chromium, Total {EPA 6010}
Chromium, Total {EPA 6020}
Copper {EPA 6010}
Copper {EPA 6020}
Lead {EPA 6010}
Lead {EPA 6020}
Mercury {EPA 7470}
Molybdenum {EPA 6010}
Molybdenum {EPA 6020}
Nickel {EPA 6010}
Nickel {EPA 6020}
Selenium {EPA 6010}
Selenium {EPA 6020}
Zinc {EPA 6010}
Zinc {EPA 6020}

**MICROBIOLOGY
Fecal Coliforms {SM 9222 D (MF)}
Total Coliforms {SM 9222 B (MF)}

**MINERALS
Acidity {SM 2310 B}
Alkalinity {SM 2320 B}
Chloride {EPA 300.0}
Chloride {SM 4500-Cl E}
Fluoride {EPA 300.0}
Hardness {SM 2340 B or C}
Sulfate {ASTM D516-90, 02}
Sulfate {EPA 300.0}
Sulfide {SM 4500-S-2 D}
Sulfide {SM 4500-S-2 F}
Sulfite {SM 4500-SO3-2 B}

**MISCELLANEOUS
Bromide {EPA 300.0}
Color {SM 2120 B}
Conductivity {EPA 120.1}
Conductivity {SM 2510 B}
Cyanide {EPA 335.4}
Cyanide {SM 4500-CN E}
Hydrogen Ion (pH) {SM 4500-H B}
Oil & Grease {EPA 1664}
Phenolics {EPA 420.1}
Phenolics {EPA 420.4}
Turbidity {EPA 180.1}

**NUTRIENTS
Ammonia {EPA 350.1}
K Nitrogen {EPA 351.2}
Nitrate-Nitrite {EPA 300.0}
Nitrate-Nitrite {EPA 353.2}
Nitrate-Nitrite {SM 4500-NO3 F}
Nitrate {EPA 300.0}

Nitrate {EPA 353.2}
Nitrite {EPA 300.0}
Nitrite {SM 4500-NO2 B}
Organic-Nitrogen {TKN-NH3-CAL}
Ortho-phosphate {EPA 300.0}
Ortho-phosphate {EPA 365.1}
Phosphorus {EPA 365.1}

**ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC)
{EPA 601} 1,1-Dichloroethane
{EPA 601} 1,1-Dichloroethene
{EPA 601} 1,1,1-Trichloroethane
{EPA 601} 1,1,2-Trichloroethane
{EPA 601} 1,1,2,2-Tetrachloroethane
{EPA 601} 1,2-Dichlorobenzene
{EPA 601} 1,2-Dichloroethane
{EPA 601} 1,2-Dichloropropane
{EPA 601} 1,3-Dichlorobenzene
{EPA 601} 1,4-Dichlorobenzene
{EPA 601} 2-Chloroethyl vinyl ether
{EPA 601} Bromodichloromethane
{EPA 601} Bromoform
{EPA 601} Bromomethane (Methyl bromide)
{EPA 601} Carbon tetrachloride
{EPA 601} Chlorobenzene
{EPA 601} Chloroethane
{EPA 601} Chloroform
{EPA 601} Chloromethane (Methyl chloride)
{EPA 601} cis-1,3-Dichloropropene
{EPA 601} Dibromochloromethane
{EPA 601} Dichlorodifluoromethane
{EPA 601} Methylene chloride (Dichloromethane)
{EPA 601} Tetrachloroethene (Perchloroethylene)
{EPA 601} trans-1,2-Dichloroethene
{EPA 601} trans-1,3-Dichloropropene
{EPA 601} Trichloroethene (Trichloroethylene)
{EPA 601} Trichlorofluoromethane
{EPA 601} Vinyl chloride
{EPA 602} 1,2-Dichlorobenzene
{EPA 602} 1,3-Dichlorobenzene
{EPA 602} 1,4-Dichlorobenzene
{EPA 602} Benzene
{EPA 602} Chlorobenzene
{EPA 602} Ethylbenzene
{EPA 602} Toluene

**ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC/MS)
{EPA 624} 1,1-Dichloroethane
{EPA 624} 1,1-Dichloroethene
{EPA 624} 1,1,1-Trichloroethane
{EPA 624} 1,1,2-Trichloroethane
{EPA 624} 1,1,2,2-Tetrachloroethane
{EPA 624} 1,2-Dichlorobenzene
{EPA 624} 1,2-Dichloroethane
{EPA 624} 1,2-Dichloropropane
{EPA 624} 1,3-Dichlorobenzene
{EPA 624} 1,4-Dichlorobenzene
{EPA 624} 2-Chloroethyl vinyl ether
{EPA 624} Acrolein
{EPA 624} Acrylonitrile
{EPA 624} Benzene

{EPA 624} Bromodichloromethane
{EPA 624} Bromoform
{EPA 624} Bromomethane (Methyl bromide)
{EPA 624} Carbon tetrachloride
{EPA 624} Chlorobenzene
{EPA 624} Chloroethane
{EPA 624} Chloroform
{EPA 624} Chloromethane (Methyl chloride)
{EPA 624} cis-1,3-Dichloropropene
{EPA 624} Dibromochloromethane
{EPA 624} Ethylbenzene
{EPA 624} Methylene chloride (Dichloromethane)
{EPA 624} Tetrachloroethene (Perchloroethylene)
{EPA 624} Toluene
{EPA 624} trans-1,2-Dichloroethene
{EPA 624} trans-1,3-Dichloropropene
{EPA 624} Trichloroethene (Trichloroethylene)
{EPA 624} Trichlorofluoromethane
{EPA 624} Vinyl chloride

**ORGANIC CHEMISTRY (MEASUREMENT BY GC)
{EPA 608} 4,4'-DDD
{EPA 608} 4,4'-DDE
{EPA 608} 4,4'-DDT
{EPA 608} Aldrin
{EPA 608} alpha-BHC (alpha-Hexachlorocyclohexane)
{EPA 608} beta-BHC (beta-Hexachlorocyclohexane)
{EPA 608} Chlordane
{EPA 608} delta-BHC
{EPA 608} Dieldrin
{EPA 608} Endosulfan I
{EPA 608} Endosulfan II
{EPA 608} Endosulfan Sulfate
{EPA 608} Endrin
{EPA 608} Endrin aldehyde
{EPA 608} gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
{EPA 608} Heptachlor
{EPA 608} Heptachlor epoxide
{EPA 608} PCB-1016
{EPA 608} PCB-1221
{EPA 608} PCB-1232
{EPA 608} PCB-1242
{EPA 608} PCB-1248
{EPA 608} PCB-1254
{EPA 608} PCB-1260
{EPA 608} Toxaphene
{EPA 614} Azinphos-methyl (Guthion)
{EPA 614} Diazinon
{EPA 614} Disulfoton
{EPA 614} Malathion
{EPA 614} Parathion ethyl
{EPA 614} Parathion methyl
{EPA 615} 2,4-D
{EPA 615} 2,4-DB
{EPA 615} Dichlorprop
{EPA 615} Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
{EPA 615} MCPA
{EPA 615} MCPP

**ORGANIC CHEMISTRY (MEASUREMENT BY GC/MS)
{EPA 625} 2-Chloronaphthalene

{EPA 625} 2-Chlorophenol
{EPA 625} 2-Methyl-4,6-dinitrophenol
{EPA 625} 2-Nitrophenol
{EPA 625} 2,2'-Oxybis(1-chloropropane)
{EPA 625} 2,4-Dichlorophenol
{EPA 625} 2,4-Dimethylphenol
{EPA 625} 2,4-Dinitrophenol
{EPA 625} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 625} 2,4,6-Trichlorophenol
{EPA 625} 2,6-Dinitrotoluene
{EPA 625} 3,3'-Dichlorobenzidine
{EPA 625} 4-Bromophenyl phenyl ether
{EPA 625} 4-Chloro-3-methylphenol
{EPA 625} 4-Chlorophenyl phenyl ether
{EPA 625} 4-Nitrophenol
{EPA 625} Acenaphthene
{EPA 625} Acenaphthylene
{EPA 625} Anthracene
{EPA 625} Benzidine
{EPA 625} Benzo(a)anthracene
{EPA 625} Benzo(a)pyrene
{EPA 625} Benzo(b)fluoranthene
{EPA 625} Benzo(g,h,i)perylene
{EPA 625} Benzo(k)fluoranthene
{EPA 625} Benzyl butyl phthalate
{EPA 625} Bis(2-chloroethoxy)methane
{EPA 625} Bis(2-chloroethyl)ether
{EPA 625} Bis(2-ethylhexyl)phthalate
{EPA 625} Chrysene
{EPA 625} Di-n-butyl phthalate
{EPA 625} Di-n-octyl phthalate
{EPA 625} Dibenzo(a,h)anthracene
{EPA 625} Diethyl phthalate
{EPA 625} Dimethyl phthalate
{EPA 625} Fluoranthene
{EPA 625} Fluorene
{EPA 625} Hexachlorobenzene
{EPA 625} Hexachlorobutadiene
{EPA 625} Hexachlorocyclopentadiene
{EPA 625} Hexachloroethane
{EPA 625} Indeno(1,2,3-cd) pyrene
{EPA 625} Isophorone
{EPA 625} N-nitroso-di-n-propylamine (NDPA)
{EPA 625} N-nitrosodimethylamine (NDMA)
{EPA 625} N-Nitrosodiphenylamine
{EPA 625} Naphthalene
{EPA 625} Nitrobenzene
{EPA 625} Pentachlorophenol
{EPA 625} Phenanthrene
{EPA 625} Phenol
{EPA 625} Pyrene

**RESIDUES
Residue, Filterable (TDS) {SM 2540 C}
Residue, Non Filterable (TSS) {SM 2540 D}
Residue, Settleable {SM 2540 F}
Residue, Total {SM 2540 B}
Residue, Volatile {EPA 160.4}

End of Parameter List

Brooks Rand Labs, LLC.

COMPREHENSIVE QUALITY ASSURANCE PLAN

for the

ANALYTICAL SERVICES DIVISION

of

BROOKS RAND LABS

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Revision 025
February 2012

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LABORATORY'S APPROVED SIGNATORIES

Michelle Briscoe – VP Analytical Services (Technical Director) — Date: 2/3/12
(effective upon sign-off Lead technical Director)

Annie Carter – Laboratory Manager (Deputy Technical Director) — Date: 2-6-12
(to sign-off upon return from leave)

Frank McFarland – Quality Assurance Manager — Date: 2/3/12

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2.0 Statement of Policy

The Brooks Rand Labs' (BRL) Analytical Services Division is committed to sound and useful quality assurance/quality control (QA/QC) management practices resulting in the production of accurate analytical data. The principal focus of the analytical laboratory is to provide specialized analytical services for trace metals analysis in environmental samples with an emphasis on ultra-low detection limits, metals speciation, and unusual or non-routine matrices.

Obtaining accurate data is dependent upon an effective and consistent quality assurance program. To meet this need, National Environmental Laboratory Accreditation Conference (NELAC) and Department of Defense Quality Systems Manual (DoD QSM) standards have been incorporated into BRL's quality assurance program. Internal audits are conducted by BRL, and external audits of BRL's facilities are conducted by the Florida Department of Health (DOH) Environmental Laboratory Accreditation Program every two years to ensure that BRL meets the requirements of NELAC standards and by ANSI-ASQ National Accreditation Board/ACLASS every two years to ensure that BRL meets the requirements of the DoD QSM. Reciprocity NELAC accreditation is granted by Oregon Environmental Laboratory Accreditation Program, New York State DOH, New Jersey Department of Environmental Protection, State of Maine Department of Health and Human Services, and State of Louisiana Department of Environmental Quality. BRL is also accredited by the Washington State Department of Ecology and reciprocity accreditation is granted by the California State Department of Health Services. The Washington State Department of Ecology routinely conducts audits of BRL's facilities every 3 years to ensure that BRL's quality assurance program meets the agency's specific requirements. Additionally, periodic external audits initiated by clients serve to ensure that Brooks Rand Labs continually meets the specific requirements of our cliental.

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Brooks Rand Labs management is committed to continually improving the quality assurance program. The BRL quality assurance program is implemented through a team effort across the entire laboratory group. All personnel concerned with environmental testing activities within Brooks Rand Labs must familiarize themselves with the quality system documentation [Comprehensive Quality Assurance Plan (CQAP) and all relevant standard operating procedures (SOP)] and implement the documented policies and procedures in their work. A listing of the general considerations and objectives of the overall program are as follows:

- *Maintenance of sample integrity.* Integrity is maintained by following documented and accepted sample handling procedures for the preservation, custody, storage, labeling, and record keeping associated with samples received by the laboratory.

- *Use of approved analytical methods.* Analytical methods and related procedures approved by the EPA are readily available. These are read and followed by all analysts. In addition, BRL is on the cutting edge of method development for the analyses of trace metals. All BRL-developed methods undergo rigorous testing and validation before they are approved by BRL scientists for use in the analysis of customer samples.

- *Regular evaluation of analytical results.* The results from quality control tests and from sample analyses are continually evaluated to identify method weaknesses and/or to detect a need for further analyst training.

- *Instrumentation performance and maintenance.* Determination of instrument performance level by frequent calibration and the analyses of performance evaluation samples, and through scheduled preventive maintenance, is documented on a real-time basis. Instrument calibration is performed as part of each analytical procedure.

- *Data reduction and report formatting.* Various levels of data review from acquisition to the final report are incorporated to minimize any potential errors in the final data. The report format is variable from a standard format to a customized data package, with or without electronic data deliverables (EDD).

- *Method performance (precision and bias) documentation.* Data from analyses are monitored using control charts to assess performance and to detect trends.

- *Regular evaluation of the quality system.* Brooks Rand Labs management is committed to continually improve the quality system. Annual reviews of all standard operating procedures and the CQAP, as well as routine audits of the laboratory and management reviews are some of the procedures used to find and correct deficiencies in the quality system.

Brooks Rand Labs management is committed to professional laboratory practices and to the quality of our environmental testing in providing services to our clients. The above considerations are documented to ensure the quality of the data generated by BRL. Subsequent sections of this manual will detail the various elements of the QA program developed and practiced by the laboratory.

The QA program is structured such that the CQAP is the primary reference for quality policies and procedures. As long as the CQAP contains all of the necessary requirements of the quality system, then no additional SOP is necessary. If there is a discrepancy between the CQAP and any SOP, the policy or procedure contained in the CQAP takes precedence and the discrepancy must be resolved as quickly as feasible. Any written directions that disagree with the CQAP and SOPs is considered a departure from the approved QA plan and may not be followed unless it has been approved by the QA Officer and the Vice President of Analytical Services. Refer to Section 8.5 for details on how any exceptional departure from BRL procedure is handled.

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3.0 Organization and Responsibility

3.1 Duties and Responsibilities of Personnel

The laboratory staff is organized in such a way that all analytical personnel are trained in a variety of laboratory duties. Individuals are specialized in their area of primary responsibility, but training overlaps so that there are always secondary personnel trained to perform the primary functions of staff that may be absent. Specific responsibilities have different minimum qualification requirements. The descriptions of responsibilities and their minimum qualifications are listed in Table 3.1.

TABLE 3.1 RESPONSIBILITIES AND MINIMUM QUALIFICATIONS

Title	Responsibilities	Minimum Qualifications
VP of Analytical Services	Oversees operations of the laboratory, including: management of personnel and analytical services, contracting, client services, sales & marketing, QA/QC, R&D, budgeting, and financial controls	Bachelors degree in physical sciences (advanced degree or equivalent experience preferred) and 15 years experience in the environmental analytical lab business, with 10 years in management positions
Laboratory Manager	Oversees operations of the laboratory, including: management of all lab personnel and all analytical services, R&D, method development, facilities improvements, and scheduling	Bachelors degree in physical sciences and 6 years experience in the environmental lab business, with 5 years in management positions
Technical Directors	Oversees operations of the laboratory, including: maintaining instrumentation and equipment, technical oversight, method development, validation, and approval, R&D, responsible for ensuring laboratory compliance with the NELAC, DoD, and all other accrediting authority standards	Bachelors degree in physical sciences (advanced degree or equivalent experience preferred) with 24 hours of college chemistry credits, and 3 years experience in the environmental trace metals analytical lab business, with 1 year in a supervisory position
Project Management Group Lead	Oversees the project management group and manages client projects, including: internal communication of client requirements, reporting to client	Bachelors degree in physical sciences or equivalent and 3 years experience in the environmental lab business
Project Manager	Manages client projects including: internal communication of client requirements, reporting to client	Bachelors degree in physical sciences or equivalent and 1 year experience in the environmental lab business

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TABLE 3.1 RESPONSIBILITIES AND MINIMUM QUALIFICATIONS (CONTINUED)

Title	Responsibilities	Minimum Qualifications
QA Manager	Oversees QA group; has the authority and is responsible for implementing, maintaining, and improving the QA program, ensuring that all personnel understand their contribution to the QA program, ensure that communication takes place at all levels regarding the effectiveness of the QA program, evaluating the effectiveness of training, using all available tools to monitor trends and continually improve the QA program, and ensuring laboratory compliance with the TNI, DoD, and all other accrediting authority standards	Bachelors degree in physical sciences (advanced degree preferred) and 3 years lab experience with 1 year of applied QA principles
QA Associate	Assist QA Manager in duties	Bachelors degree in physical sciences and 6 months experience in the environmental lab business or Associates degree and 1 year of analytical lab experience with 6 months of applied QA principles.
QA Assistant (as necessary)	Assist QA Manager in duties	Bachelors degree in physical sciences or Associates degree and 6 months experience in the environmental lab business
Mercury Lab Group Leader	Oversees the mercury analytical group including: training records, sample preparation, analysis, and scheduling within the group. Overseas classical chemistry methods for percent total solids and total volatile solids performed by the mercury group.	Bachelors Degree in physical sciences and 1 year of analytical lab experience as an analyst, or 5 years experience in the environmental lab business
Trace Metals Group Leader	Oversees the trace metals analytical group including: training records, sample preparation, analysis, and scheduling within the group. Overseas classical chemistry methods for percent total solids and total volatile solids performed by the trace metals group.	Bachelors Degree in physical sciences and 1 year of analytical lab experience as an analyst, or 5 years experience in the environmental lab business
Analyst	Perform and document sample preparations and analyses following SOPs, instrument calibration and reagent/standard preparation	Bachelors Degree in physical sciences or equivalent and 1 year of analytical lab experience or Associates degree with 2 years analytical lab experience.
Sample Control Group Leader	Oversees sample control group including: training, custody of samples, and scheduling within the group. Overseas classical chemistry method for total suspended solids performed by the sample control group.	Associates Degree and 1 year of analytical lab experience
Lab Technicians	Individual Lab Technicians will perform some or all of the following: Receive, log-in, and store samples; decontaminate lab ware; prepare bottle and reagent testing; prepare bottle orders/sampling kits; dispose of samples.	Associates degree or equivalent college education or High School Graduate with 6 months experience in the environmental lab business

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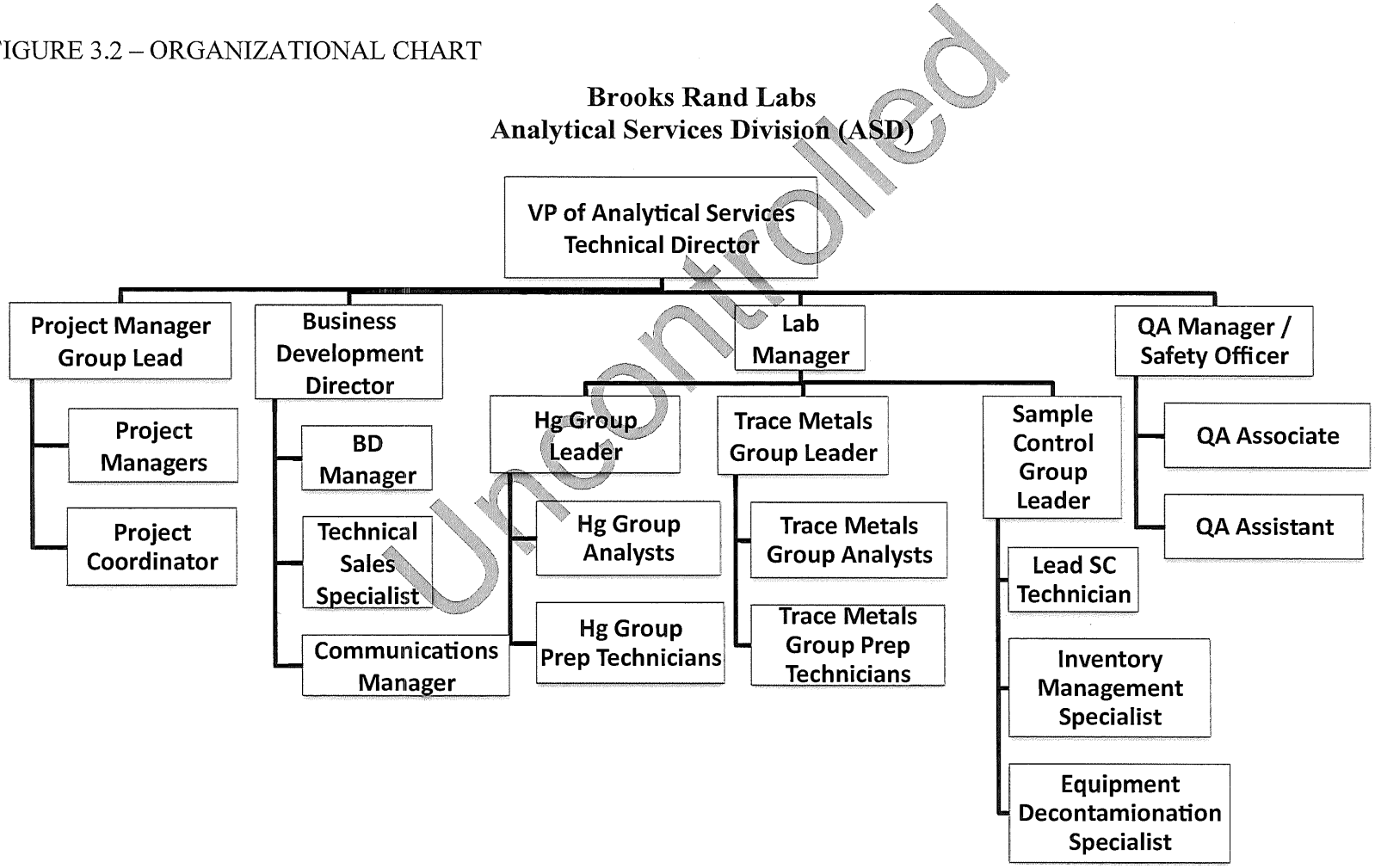
3.2 BRL Organization

There is a defined chain of responsibility along which the laboratory staff is organized. The organization of the laboratory personnel is shown in Figure 3.2.

FIGURE 3.2 – ORGANIZATIONAL CHART



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3.3 Managerial Responsibilities for the Detection of Improper, Unethical, and Illegal Actions

Brooks Rand Labs holds management responsible for ensuring that all client data is properly and accurately reported. To this end, management works diligently to ensure that all employees of BRL are free from undue commercial, financial, and any other pressures that may adversely affect the quality of their work. In addition, the management of BRL works proactively to detect any improper, unethical, or illegal actions that might arise due to such pressures before such actions can adversely affect client data.

All information relevant to client results, from sample receipt to the analysis and reporting of data, goes through several levels of review. Management keeps track of all work that appears sloppy or contains mistakes and all changes made to the LIMS are electronically tracked and stamped with the date/time of the change and who instigated it. All employees routinely meet with senior management at which time work-related problems are discussed so that any undue pressures can be brought out into the open. Immediate supervisors speak daily with all employees and strive to keep aware of the activities and general attitudes of those employees for which they are responsible. Employee work is additionally reviewed during monthly audits.

All employees receive training to ensure that each is fully aware as to what constitutes improper, unethical, and illegal behavior and what the consequences are for such behavior (refer to BRL SOP BR-1101) and must sign the "Brooks Rand Labs Ethical and Legal Responsibilities Agreement" form stating that they agree to adhere to all aspects of the ethics program at BRL prior to working with client samples. Any employee who becomes aware of unethical behavior is encouraged to report the behavior to BRL management. Any employee should feel free to report such behavior to any manager, on up to the President of BRL. Brooks Rand Labs management assures that any reporting of improper, unethical, or illegal behavior will remain strictly confidential. If such behavior is detected, the responsible employee is immediately brought before senior management. If the behavior is unintentional and appears to be caused by undue pressures, every effort is made by management to eradicate the pressures. If the behavior is deemed willful, then senior management is responsible for determining the best course of action for BRL and its clients. Under no circumstances is any behavior that might adversely affect the quality of the data produced by BRL tolerated.

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4.0 Training

4.1 Technical Training

Brooks Rand Labs personnel are trained in every aspect of their duties prior to the analysis of client samples. An experienced technician who has previously demonstrated their capability to perform the procedures for which a new employee is being trained directly supervises all training.

Brooks Rand Labs is also on the cutting edge in the development of new techniques for the analysis of trace metals. In such situations where a scientist is developing a new technique, they must train themselves in the new procedures. The lead scientist is expected to develop the training protocol by which future technicians will be trained in the method.

Regardless of how training takes place, an initial demonstration of capability (IDOC) for each method must be successfully completed as per NELAC and DoD QSM standards prior to any analysis of client samples. The DOC serves as an indicator of the successful completion of training. From then on, the consistent meeting of quality control criteria serves as the ongoing DOC. The QA Manager reviews the ongoing DOC annually to ensure the continued proficiency of each technician. The conclusions of these reviews are recorded in each employee's training records.

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4.2 Safety Training

All BRL employees receive training in laboratory safety that they are required to review on an annual basis. Safety training includes "Right-to-Know" training as to the potential chemical and physical hazards of working in an environmental laboratory and how best to reduce these hazards. Training also includes what procedures to take in the case of a laboratory accident and the locations of all safety and first aid equipment.

4.3 Training in Legal and Ethical Rights and Responsibilities

All BRL employees receive annual training in their legal and ethical rights and responsibilities. This training includes the following topics: Non-discriminatory workplace; drug free workplace; data manipulation; and workplace ethics. This training also specifies the potential punishments and penalties for improper, unethical, or illegal actions performed by BRL employees. The Brooks Rand Labs data integrity plan (SOP BR-1101) discusses in detail the specific legal and ethical rights and responsibilities of employees at BRL. Training on this SOP is required for all personnel in the Analytical Services department.

In conjunction with this training, each employee must attest that they are free from any commercial, financial, and other undue pressures, which might adversely affect the quality of their work prior to working with client samples.

4.4 Documentation of Training

Each employee is responsible for documenting all training in their personal training records and each Group Lead must review the training records for all employees within their group to ensure

completeness. At a minimum, the Quality Assurance Manager audits the training records quarterly and reports any deficiencies to the Group Leads and the Laboratory Manager so that they can be corrected. Training records are updated annually to ensure that all personnel continue to be proficient in their assigned tasks. Records for each type of training (i.e. Technical, safety, and legal and ethical) are maintained and stored for a minimum of five years, regardless of the employment status of the individual.

4.5 Additional Training

The Quality Assurance Manager reviews each employee's training records quarterly. Any deficiencies found are recorded in the monthly QA audits. In addition, the technical abilities of each employee are constantly monitored through the analysis of quality control samples. If quality control criteria are not consistently met, additional training is required under the supervision of the Laboratory Manager. Any additional training is fully documented and a new DOC must be successfully completed before the technician may restart analyzing client samples.

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5.0 Capabilities and Quality Assurance Objectives

5.1 Acceptance of New Work

The VP of Analytical Services (along with any necessary assistance from the Project Management Group Lead, project managers, QA Manager, and individual group leaders) carefully reviews the specific requirements of every contract before any new work is accepted by Brooks Rand Labs. BRL will accept a project only after the VP of Analytical Services has ensured that BRL possesses the appropriate facilities and resources to carry out the work as specified by the client.

5.2 Capabilities of Organization

BRL is an analytical laboratory primarily focused on providing analytical services for the determination of low-level trace metals and metals speciation in environmental samples. Brooks Rand Labs specialties are threefold: 1) providing the lowest detection limits commercially available, 2) speciation of oxidation state and organometallic forms; and 3) analysis of non-routine matrices.

Each sample preparation method followed at Brooks Rand Labs is dependent upon the analyte of interest and the type of matrix being analyzed. Refer to the specific analytical method or standard operating procedure (SOP) for a description of each particular preparation method utilized at BRL. Other sample preparation methods may be used upon request for specific enforcement or compliance-based contracts.

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5.3 Quality Assurance Objectives

Brooks Rand Labs is dedicated to providing the finest services to its clients. To meet this objective, every position at BRL is staffed with trained personnel and competent managers who possess the authority and resources to produce meaningful metals data and meet the needs of our clients.

The primary purpose of the Quality Assurance Program at BRL is to ensure that all data reported to our clients are accurate and reproducible. To this end, BRL implements procedures to ensure that all staff are qualified and fully trained to perform their specific laboratory duties, that laboratory instrumentation is properly maintained and calibrated, and that materials are adequately stocked and tested prior to use in the laboratory. All data reported by the laboratory undergoes several levels of review before being approved for release by the Quality Assurance Department.

5.4 Subcontracted Work

Occasionally, a client may wish to work directly through Brooks Rand Labs even for analyses that BRL does not currently perform. Under these conditions, BRL will subcontract work to other laboratories with the client's approval. The subcontracted laboratories must meet all project specific requirements before samples may be delivered.

Subcontract laboratories are selected by Brooks Rand Labs based a culmination of many factors. These include but are not limited to laboratory capabilities, past work experience, data quality (including data presentation), accreditation / certification, price, turnaround time, customer service,

and electronic data deliverable (EDD) capabilities. Example reports can be requested from a potential subcontract laboratory.

Once subcontracted work has been contracted between Brooks Rand Labs and the client, a purchase order agreement is issued by Brooks Rand Labs to the subcontract laboratory.

All samples are logged into Brooks Rand Labs' Laboratory Information Management System and a subcontract order is created. When samples are submitted to the subcontract laboratory, the are accompanied with the original chain-of-custody form and the subcontract order.

The subcontract laboratory will email the appropriate Brooks Rand Labs Project Manager with the final report and EDD (if requested). The Project Manager will then forward the report to the Quality Assurance Manager. Data is reviewed and notes will be written regarding the data set. If there are outstanding issues, the Project Manager will contact the subcontract laboratory and work to resolve the issue/gain clarification. Depending on the reporting level, Brooks Rand Labs may supply a cover letter to the client regarding the data set provided by the subcontract laboratory. Final reports (and EDDs) will be emailed by the Project Manager to the client.

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6.0 Sampling Procedures and Requirements

6.1 Sampling Capabilities

BRL conducts field sampling on a very infrequent basis. Therefore, the following sampling procedure topics are only briefly addressed:

Sampling Equipment - All sampling equipment is decontaminated and/or tested prior to and following every sampling event and stored in a secure designated area. Any equipment requiring calibration or maintenance, as specified by the manufacturer's instructions, is placed on a routine calibration/maintenance schedule.

Field Sample Documentation - During site visits, minimal notes regarding specific field parameter measurements, general observations, hydrologic conditions, and overall suitability are documented, if applicable. These notes are entered as Work Order Comments in BRL's LIMS for the related project(s).

Sample Dispatch - Field samples are relinquished by the sample collection team to BRL's Sample Control Group following a strict chain-of-custody process. Time, date, and samplers signatures are documented.

Field Reagent and Waste Disposal - All field reagents and wastes generated or used during field sampling activities should be collected and disposed of in accordance with all state and federal regulations.

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6.2 List of Equipment Provided by BRL for Sampling

TABLE 6.2 - CONTENTS OF BRL SAMPLING KITS

Equipment	Construction	Use	Parameter Groups
Sample Container(s)	Teflon® – FEP, PFA Fluorinated – FLPE Glass – I-Chem 200 series HDPE (for solids only) Ziploc® bags (some biota)	Sampling/Storage	Mercury and monomethyl mercury in water/soil/biota
	HDPE bottles LDPE, HDPE, or PP jars Ziploc® bags	Sampling/Storage	Trace Metals, except Hg, in water/soil/biota
	Iodated carbon (IC) Traps or Gold Coated Media in Ziploc® bags	Sampling/Storage	Mercury in air
Shipping Containers	Plastic cooler or cardboard box	Sample Transport	All parameter groups
Gloves, Clean Room	Vinyl, non-powdered	Sampling	All parameter groups

6.3 Decontamination Procedures

Client Equipment

BRL supplies sample containers for all analyses. Clients may provide their own sample containers at their discretion, but Brooks Rand Labs cannot guarantee the cleanliness of containers that have not been cleaned and/or tested by Brooks Rand Labs.

Cooler/shipping containers

All coolers are cleaned prior to use for shipping samples or sample containers. Appropriate sample containers are placed in the coolers to make a sampling kit. Sampling kits are sent via freight carrier (UPS or FedEx) to the sampling team.

Sample Containers

Due to the possible occurrence of false positive results due to trace metals contamination, it is extremely important that all water samples are collected in rigorously acid-cleaned or pretested containers that are double-bagged in poly bags and suitable to the analyses to be performed.

6.4 Sampling Protocol

BRL recommends that all samples to be analyzed for trace metals are collected following the guidelines laid out in EPA Method 1669 (7/96): Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels.

6.5 Sample Preservation, Holding Times, Container Types, and Required Volumes

All preservation reagents used by BRL are analytical grade or better. For mercury analysis, samples not being filtered in the lab may be sent to BRL at ambient temperature via ground shipment where they will be preserved with pretested ultra-trace BrCl. For most other parameters, the field sampling crew can add the appropriate preservative (See Table 6.5) or they should send the samples on ice via overnight shipping to be preserved at BRL.

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TABLE 6.5 - SUMMARY OF SAMPLE CONTAINERS & PRESERVATIVES

Parameter	Method	Minimum Volume	Container	Means of Preservation	Holding Time
A. Water[1]					
As and Se (for HGAAS analysis ONLY)	BR-0020	500 mL	HDPE[2]	0.4% (v/v) 12 M HCl; pH < 2 within 28 days of collection	6 months
Arsenic (As) Speciation	EPA 1632	125 mL		0.4% (v/v) 6 M HCl at time of collection; Store in Dark at 0-4 °C[3]	28 days
Selenium (Se) Speciation	BR-0061	250 mL		Field-filtration recommended, especially for samples with high levels of solids; unpreserved; zero headspace; keep dark; maintain collection temperature as best possible	Dependant on sample matrix
MeHg (Freshwater)	EPA 1630	250 mL	Fluoropolymer, FLPE, or Glass with Fluoropolymer lined lids	0.4% (v/v) 12 M HCl; Store in Dark at 0-4° C	6 months
MeHg (Salt Water ≥ 10 ppth salinity)	EPA 1630	250 mL		0.2% (v/v) 18 M H_2SO_4; In Dark at 0-4 °C	6 months
Total Hg	EPA 1631E	250 mL		Preserve to pH < 2 in original sampling container within 28 days	90 days
Acid-labile Hg	BR-0003	250 mL		0.8% 12 M HCl within 24 hrs of collection; Store in Dark at 0-4 °C	Analyze 21 days (± 3 days) after preserv. (being investigated)
Total Volatile Hg	BR-0005	1-L	Glass with Fluoropolymer lined lids	No head space; Store in Dark at 0-4 °C	24 hours
Reactive Hg	In-House	250 mL	Gold traps stored in plastic bags	Field collect reactive Hg onto gold traps and mail overnight	Gold traps stable for 5 days from collection
Fe (II)	SM3500B	40 mL	Glass with Teflon-lined lid w/preservation	0-4 °C, dark, 1% (v/v) 12 M HCl at collection (pre-preserved vial)	48 hours
ICP-MS Metals (Freshwater)	EPA 1638, Mod.	125 mL	HDPE	1% (v/v) HNO_3; pH < 2 in lab, should be acidified within 14 days of collection[4]	6 months
ICP-MS Metals (Brackish or Seawater)	EPA 1640, Mod.	1 L	HDPE	0.1% (v/v) HNO_3 (APDC Prep) or 0.2% (v/v) HNO_3 (RP prep) or 1% (v/v) HNO_3 (chelating column procedure) in lab, should be acidified within 14 days of collection	6 months
Cr (VI)	SW 7196A	125 mL	HDPE	Store at 0-4 °C	24 hours
	SW 7196A, Mod.			16 mL/L of 25% NaOH (pre-preserved bottle); store at 0-4 °C	30 days
TSS	EPA 160.2	500 mL	HDPE	Store at 0-4 °C	7 days
Lab pH, hydrogen ion	EPA 150.1	25 mL	Glass or HDPE	0-4 °C	Analyze immediately

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[1] Samples to be analyzed for dissolved analytes must be filtered prior to preservation. This should preferably be done on site in the field. If this is not possible, the sample must be chilled (0-4 °C) and filtered within 48 hours of collection (24 hours for mercury samples).
[2] High Density Polyethylene
[3] All temperature ranges of 0-4 °C assume an acceptable measured temperature of ± 2 °C from either extreme as long as the samples do not freeze.
[4] While Brooks Rand Labs suggests that samples be acidified within 14 days of collection, there is no good scientific evidence to indicate that not doing so will impact data quality as long as samples are acidified in the original collection container for a minimum of 24 hours prior to analysis.

TABLE 6.5 - SUMMARY OF SAMPLE CONTAINERS & PRESERVATIVES (CONTINUED)

Parameter	Method	Minimum Volume	Container	Means of Preservation	Holding Time
B. Wet Sediments and Soils					
Total Metals	Various	Fill 4 oz jar	FLPE, Glass or HDPE	0-4 °C during shipping, ≤ 4 °C and in dark in lab	1 year[5]
Metal Species (other than As species and Reactive Hg)	Various	Fill 4 oz jar	FLPE, Glass or HDPE	0-4 °C during shipping, -15 to -30 °C and in dark in lab	1 year
As Species	EPA 1632	Fill 4 oz jar	FLPE, Glass or HDPE	0-4 °C during shipping, < -18 °C in lab	2 years
Reactive Hg	In-House	Fill 4 oz jar	FLPE or HDPE	Immediately chill to ≤ 4 °C and freeze within 48 hours of collection, store < -18 °C in lab	90 days
Cr (VI)	SW 3060a/ 7196a	Fill 4 oz jar	FLPE, Glass or HDPE	0-4 °C during shipment; ≤ 4 °C in lab	280 days
% Solids	EPA 160.3	100 mL	FLPE, Glass or HDPE	0-4 °C	7 Days[6]
C. Dry Sediments and Soils					
Total Metals	Various	Fill 4 oz jar	FLPE, Glass or HDPE	N/A (Room Temperature is OK)	1 year
Metal Species	Various	Fill 4 oz jar	FLPE, Glass or HDPE	Room Temp OK (recommended 0-4 °C during shipment; ≤ -15 °C in lab)	1 year
Cr (VI)	SW 3060a/ 7196a	Fill 4 oz jar	FLPE, Glass or HDPE	0-4 °C during shipment; ≤ 4 °C in lab	28 days
D. Wet Tissues					
Total Metals or Species (other than As)	Various	Fill 4 oz jar	FLPE, Glass, HDPE or Ziploc bags	0-4 °C during shipping, -15 to -30 °C, Dark in lab	1 year
As Species	Various	Fill 4 oz jar	FLPE, Glass, HDPE, or Ziploc bags	0-4 °C during shipping, < -18 °C in lab	2 years
E. Tissues (freeze dried)					
Total Metals	Various	Fill 4 oz jar	FLPE, Glass or HDPE	N/A (Room Temperature is OK)	1 year
Metal Species (other than As Species)	Various	Fill 4 oz jar	FLPE, Glass, HDPE, or Ziploc bags	Room Temp OK (recommended 0-4 °C during shipment; ≤ -18 °C in lab)	1 year
As Species	EPA 1632	Fill 4 oz jar	FLPE, Glass, HDPE, or Ziploc bags	N/A (Room Temperature is OK)	2 years
F. Air					
Total Hg	EPA 324 / IO-5	NA	Iodated Carbon Trap or Gold Coated media	Ends plugged, store in Ziploc® Bag	6 weeks
MeHg	BR-0011	10 L	Tenax trap	1 °C, Dark	48 hours
G. Biomonitoring					
Total Metals (including Hg) for Urine	Various	90 mL	Polyethylene Urine Specimen Container (transfer to FPE for Hg analysis)	0-4 °C during shipment; 0-4 °C in lab (or ≤ -15 °C to -30 °C in lab)	28 days (1 year if frozen – being investigated)
Total Metals and Metals Speciation in Whole Blood	Various	7 mL	7 mL royal blue top EDTA tube	0-4 °C during shipment; ≤ -15 °C to -30 °C in lab	1 year
Total Metals and Metals Speciation in Hair	Various	100 mg	Ziploc® bag	Dark, room temperature	1 year

[5] There are no established holding time limitations for solid samples.

[6] Although the standard temperature / holding time requirements for % solids are 0-4 °C for 7 days, many solid samples are frozen and held for much longer periods prior to analysis for other parameters. Ideally, sample aliquots for each parameter should be removed prior to freezing. If this has not been done and % solids analysis is required for the samples, then the aliquots for % solids should be removed at the same time as the aliquots for the other parameters to ensure similar sample characteristics between aliquots.

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6.6 BRL's Policy on Accepting Samples

Brooks Rand Labs will only accept samples for analysis from parties with whom a written contract has been jointly signed or from long-time clients in good standing with BRL's accounts receivable department. If a signed contract is not in place, samples are still received and placed on "hold." Any time-sensitive work, such as preservation or filtering, is still performed and the samples are stored appropriately. Once the Project Manager establishes the contracting paperwork, the samples are taken off hold status and the samples may be batched for further analysis. The terms under which BRL would enter into a contract are explained in section 5.1 of this document.

Once a legal contract is in place, BRL will accept client samples even if the samples have not been preserved or handled properly, but all evidence of improper preservation and/or handling will be fully documented by BRL at the time of receipt. Examples of improperly handled samples include those with holding time violations, temperature violations, pH violations, evidence of improper sampling technique, improper handling (i.e. broken custody seal), improper documentation of samples on the chain of custody (COC) form, etc.

In the case of samples that have been collected or preserved improperly, the Project Manager immediately contacts the client to determine whether the client desires to continue with the analysis of samples. At the request of the client, BRL will perform analyses of samples even if they have non-conformance issues, but all such samples shall have their results qualified to indicate the non-conformance.

In the case of improperly documented samples, the Project Manager or her agent will contact the Field Sampler to clarify any questions concerning the COC before samples are batched.

At all times, BRL reserves the right to not accept samples that are deemed to be a threat to the health or safety of BRL personnel beyond what might reasonably be expected while working within an environmental laboratory.

Refer to the sample receiving SOP (BR-0300) for specific information pertaining to BRL's sample acceptance policy.

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7.0 Sample Custody

7.1 Field Custody

Formal custody requirements begin at BRL with the shipment of sample containers to the field. Every shipment must be documented by BRL. With the exception of HDPE bottles sent for the collection of hydride, Se speciation, and all solid samples, a minimum of 10% of the bottles from 10% of the cases for each manufacturer lot # are tested for all applicable analytes prior to shipment. BRL provides Chain-of-Custody (COC) forms and two custody seals with each container shipment. Sample collection dates and times should be provided on the COC by the organization conducting the field sampling. If provided, the COC is used as documentation for sample collection dates and times. In addition, all sample container shipments are documented to track container information such as bottle cleaning batch numbers, quantity of containers shipped and their date of shipment.

While BRL does not typically provide field services, we do recommend that certain precautions be taken when collecting samples. Special consideration should be given to the procurement, transportation, preservation, and storage of samples to be analyzed. These procedures are intended to ensure that any analyte originally present in the sample matrix has not degraded and that contamination has not been introduced. For example, for mercury work, only rigorously acid-cleaned FEP, or pre-tested FLPE and glass containers with fluoropolymer lined lids may be used for water samples. Water samples to be analyzed only for total mercury by EPA Method 1631E may be shipped via ground service unpreserved as long as the samples are to be oxidized in their original sampling containers. Otherwise, water samples should either be shipped to BRL at the method-required temperature within 48 hours of collection and preserved upon receipt, or samples may be preserved in the field with the appropriate preservative as per specific method instructions. See section 6.5 of this document for container, preservation, and holding time requirements for other analyses. Tissues and other solid matrices may be stored in FLPE containers, HDPE containers, glass containers with fluoropolymer lined lids, or plastic bags/wrap. Solid samples are preserved by shipping on ice, followed by storage in a freezer at -15 to -30 °C (solids to be analyzed for arsenic speciation must be stored ≤ -18 °C).

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The courier is responsible for documenting the custody of the samples while the samples are in transit from the field to BRL.

7.2 Laboratory Custody

7.2.1 BRL Definition of Laboratory Custody

A sample is considered to be "in custody" in the laboratory if it meets one of the following criteria:

- It is in the Lead Sample Control Technician's (or designated alternate's) possession
- It is in the analyst's possession
- It was in a Lead Sample Control Technician's, designated alternate's, or analyst's possession and then locked or sealed to prevent tampering.
- It is in a secure area (i.e., storage)

7.2.2 Sample Receipt

All samples delivered to BRL are received by the Lead Sample Control Technician or designated alternate in the laboratory receiving area. Upon delivery of samples the Lead Sample Control Technician or designated alternative signs and dates the receipt and the COC form (refer to SOP BR-0301 for example of form).

Immediately after opening the cooler or other container, the Lead Sample Control Technician confirms the presence of ice, measures sample temperatures (if required), and documents the condition of the samples (intact, broken, leaking, etc.). The Lead Sample Control Technician also verifies that each container is properly labeled and sealed and compares the sample ID or field ID number against the COC form. The temperature of the samples at the time of receipt is determined by aiming a calibrated IR thermometer directly into a sample.
<Reference to temperature blanks removed>

The Lead Sample Control Technician is also responsible for ensuring that all samples are properly preserved. If any filtration or analysis of volatile mercury species is required, this should be performed before the preservation of samples. All samples must be preserved in accordance with the preservation instructions in each appropriate analytical methodology. Water samples for certain analytes do not require acidification and are stored in the refrigerator at 4 °C. If water samples that do require acidification are preserved in the field, the Lead Sample Control Technician checks the pH and documents that it is less than 2. If it is not less than 2, the measured pH is documented on the Sample Receiving Log, additional preservation reagent is added to the sample(s), and this addition is documented.

If the sample ID and the COC do not match, the seals on any of the containers are broken, the temperature of the samples is above the method specified storage limit, or the samples are not properly preserved, the Sample Control Technician notes the problem directly in the LIMS "Project Notes" for the affected work order and notifies the Project Manager. The project manager then immediately notifies the client of any concerns.

If sample containers arrive with too little sample for analysis and this is noticed at receipt, then the Sample Control Technician goes ahead and logs the sample in for all analyses requested on the COC, sets the status for the analyses on the affected sample to "cancelled", and writes "insufficient sample for analysis" in the container comments field.

All of the above information is documented at the time of receipt on the BRL Sample Receiving Checklist. This form also includes a section for describing any non-conformance issues and their resolutions. Detailed instructions for the filling out of this form, as well as an example of the form are found in SOP BR-0300. Refer to SOP BR-0300 for a detailed description of BRL's sample acceptance policy.

7.2.3 Sample Log In

When logging in samples, the Lead Sample Control Technician must check the LIMS "Project" information against the samples received to ensure that the work has been authorized. If any discrepancies exist, the Project Manager is immediately notified and the discrepancy is noted on the BRL Sample Receiving Checklist.

All samples are given a unique sample identification number at the time of sample log in. This number consists of a work order number that is unique to each sample shipment received and a

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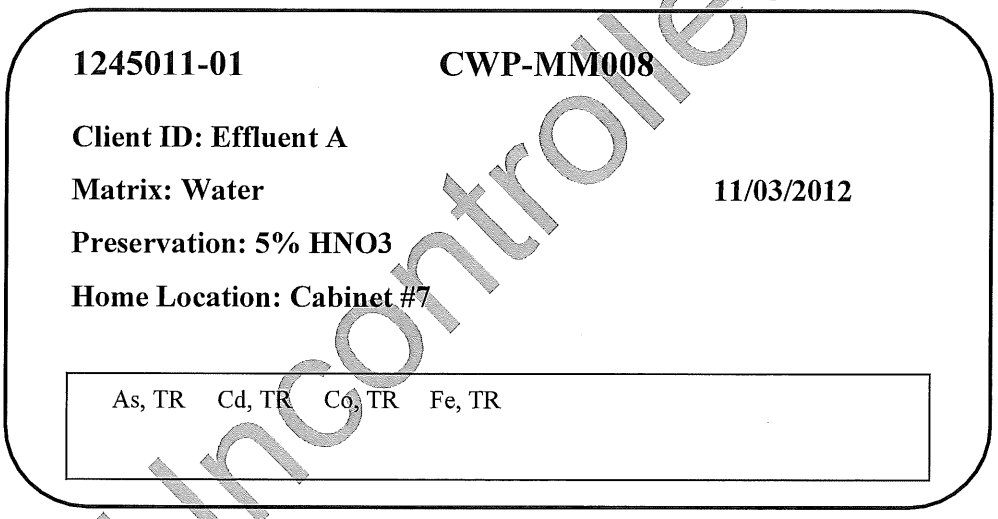
sample number for each sample within that particular shipment. Work order numbers consist of a 7-digit code (yyww###) where the first two numbers are associated with the year, the next two are associated with the week of the year, and the final three are associated with the number of shipments received in that week (e.g., the eleventh sample shipment received in the 45th week of 2012 is given the work order number 1245011). The samples within a shipment are then each identified by sequential numbering. For example, if three samples were received in the 1245011 shipment they would be given the sample numbers 1245011-01, 1245011-02, and 1245011-03. The client's sample ID and the BRL ID numbers are both entered into the LIMS. The BRL work order numbers (in addition to the client's ID numbers) are referenced during all laboratory preparations and analyses.

When a bottle is removed from the Ziploc® bags in which it was sent, the bottle should be rinsed with clean DIW (for low-level samples) and/or wiped with a clean cloth. Bottles are then labeled with the BRL sample number, customer project number, client sample ID, matrix, date of sample receipt, preservation, storage location, and list of analytes to be analyzed for. An example of a BRL sample label is as follows:



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After all of the log-in information is recorded in the LIMS, the BRL Work Order Receipt form (refer to SOP BR-0300) is generated from the LIMS and is signed and dated by the Lead Sample Control Technician.

Custody of the original samples is tracked in the LIMS by updating the storage location of the samples in the bench sheet every time that they are moved.

7.2.4 Sample Storage

All samples are stored in a secure area. A secure area is defined as a locked area within the premises of BRL with restricted access. To satisfy these custody provisions, the laboratory implements the following procedures:

- Access doors to the laboratory are kept locked, except during normal working hours
- Visitors must sign in and are escorted while in the laboratory
- Samples remain in the secure area until they are removed for sample preparation or analysis

After the samples are logged in, the Lead Sample Control Technician stores them, according to their specific holding requirements, in either the refrigerator, freezer, or on shelf space in the secure sample storage cabinets

Samples requiring refrigeration or freezing are stored in facilities dedicated to secure sample storage in a sample storage room located in the northwest corner of the facilities. The samples are removed from the shipping cooler and stored in their original containers, unless damaged. Samples not requiring refrigeration are stored on shelves in the secure sample storage cabinets, which helps to protect samples from UV radiation. All standards and other chemicals used at BRL are stored separately from samples.

After the samples are stored, all sample information is placed in a folder. This information includes the client's COC form(s), a copy of the BRL Work Order Receipt form, the shipping way bill, and any other documents included with the shipment. The folder is labeled with the work order, project reference number, received date, and due date. The folder is given to the Project Manager who then reviews the information, signs and dates the BRL Work Order Receipt form, and files the folder in the "Active Customer" file located in the Project Manager's office. The "Active Customer" files are sorted alphabetically by the project reference number. Each BRL Sample Receiving Checklist is stored in sample control.

To ensure that sample holding times are met, samples for all projects are assigned a due date. Each analytical Group Lead is responsible for ensuring that all due dates (or sample turn-around times) are met. This is done by checking the LIMS to see what deliverables are approaching the due dates. In addition, all Sample Processing Forms (SPF) have due dates recorded on them for each project, which correlates to the date that the sample preparation, analysis, data review and report need to be completed. This date is generally four days prior to the final report due date in order to allow sufficient time for final report generation, review and submittal. If samples are on a rush turn-around schedule, then the final due date will be adjusted to give less time between the date on the SPF and the date that the final report must be sent to the client. When this is the case, the Project Manager is responsible to inform all laboratory personnel that the data is on a quick turn-around schedule.

The duration of original sample storage at BRL is set at two months following the submittal of the final report, unless contractual requirements indicate a longer period of storage.

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7.2.5 Sample Distribution and Tracking

The system for tracking samples through preparation and analysis consists of the LIMS, laboratory worksheets, laboratory notebooks, instrument operation logbooks, instrument printouts (raw data), and final analytical reports.

7.2.5.1 Sample Batching - After samples are received and logged-in, the samples are then batched by the analytical Group Leads. Batches are sequentially numbered starting with the letter B, then the last two digits of the year, followed by a four digit sequential number (e.g. the 805th batch in 2011 is numbered B110805. Samples are assigned to each batch in the LIMS. Sample custody is tracked electronically in the LIMS through the bench sheet.

Original samples are batched according to the method by which they are to be prepared and analyzed. At the time of batching the SPF is printed from the LIMS. Any special QA requirements and/or pertinent information provided by the client concerning the sample

preparation/analysis should be noted on the SPF. This information should be added to the project comments in the LIMS so that it will automatically appear on any SPF including samples for that project. If the project comments field is not large enough, additional notes can be made in the project **notes** field with instructions in the project comments field to "see project notes." Once batched, the status of the samples is changed from "available" to "batched" in the LIMS.

7.2.5.2 Sample Preparation - The SPF is given to the scientist responsible for sample preparation. From the time the scientist removes samples from the storage area the SPF must remain with the sample batch. All sample preparation details must be documented on a form or in a logbook. Copies of all preparation documentation, once complete, must accompany the SPF. In order to track both original samples and sample preparations the preparation technician documents the removal of original samples from their primary storage location to the preparation location and back to their storage location in real time in the LIMS at the LIMS prep bench sheet. After the original samples are logged in as being returned to storage, the preparation technician changes the samples in the prep bench sheet to "extracts." These extract samples can now be tracked separately from the original samples. The location of the extracts is entered as the preparation location. When sample preparation is finished and the extracts are moved to the lab or other storage location, this information is entered into the LIMS prep bench sheet. From then on, every time the extracts are moved, up to and including disposal, this information is updated in real time.

During sample preparation, any comments on unusual observances or deviations from the analytical method or SOP must be documented. (Note: Senior management must approve any deviations from the analytical method or SOP prior to the preparation of the samples.) Following sample preparation, the prepared samples, along with the SPF and all preparation documentation, are stored in a secure laboratory area. Once prepared, the status of the samples is changed from "batched" to "prepared" in the LIMS.

Note: If during sample preparation the technician notices that there is insufficient sample for preparation, the technician should send an email informing their Group Lead of this information and write the information on both the SPF and the benchsheet. The Group Leader should set the analysis for the affected sample to "cancelled", write "insufficient sample for analysis" in the container comments field, and send an email to the affected Project Manager and the other Group Leaders if any other analyses are affected. It is up to the Group Leaders to coordinate who will set any other affected test code's analytical status to "cancelled."

If the sample is exhausted following preparation, then the technician should make a note on the benchsheet and send an email to the Group Leader, affected Project Manager, and the QA Group. The PM then adds a note to the container comments field for all affected samples. Should the sample be inadvertently rebatched, this note will show up on any subsequent SPFs making it clear that the sample is already exhausted and cannot be reanalyzed.

7.2.5.3 Sample Analysis – When analyzing the samples, the analyst builds a sequence that contains the calibration and other sequence specific QC (ICVs, CCVs, CCBs) as well as all

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samples, including batch QC, from all of the batches analyzed as part of the sequence. When a batch is analyzed, the analyst must sign and date the SPF and update the LIMS. Any comments on unusual observances or deviations from the analytical SOP must be documented and must be referenced on the SPF. As previously mentioned, movement of the batch throughout the lab is documented in the LIMS at the prep bench sheet. The analyst then uploads the data into the LIMS and signs and dates the SPF with when this action was performed. During the upload of the data, the status of all samples is changed from "prepared" to "analyzed" in the LIMS. The analyst then performs the primary review of the data.

7.2.5.4 Primary Data Review - When the data is reviewed, the reviewer must sign and date the SPF, update LIMS, and comment on any unusual observances or deviations from appropriate. Primary data review includes checking all LIMS entries in the prep bench sheet and the data upload for accuracy, determining whether criteria is met, and preparing analyst notes about the quality of the data. The analyst then puts together the data package, which includes a printout of the Analysis Sequence form, any sequence lab bench sheets, all SPFs, all sample preparation documentation, and any analyst notes. Instrument raw data is saved electronically as a PDF file. Once the data has been primary reviewed, the status of the samples is changed from "analyzed" to "reviewed – primary" in the LIMS and the SPF is signed and dated.

7.2.5.5 Final Review - The QA Manager, or his designee, reviews the final data. After the final review, either the QA Manager or his designee must sign and date the SPF and include comments on any unusual observations and/or deviations from the analytical method or SOP. The QA Manager or his designee also updates the batch status LIMS from "reviewed – primary" to "reviewed – final." If any samples require rebatching, this is performed by QA prior to changing the status of the samples in the analyzed batch to "reviewed – final." (Refer to section 12 of this document for additional discussion of the data reduction, validation, storage, and reporting process.)

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7.2.5.6 Deviation Traceability - All documents are used to track any deviations from generally accepted handling of the samples. The main form for tracking deviation is the SPF. This form should contain any mention of unusual events or occurrences or deviations from SOPs and should list where this information can be found if relevant. Examples of possible entries on the SPF include, but are not limited to the following:

- Samples not cold when removed from refrigeration-see instrument log book.
- Samples over distilled-see distillation prep sheet.
- Samples prepared differently from SOP-see preparation notes.
- Out-of-Control calibration curve - see analyst's notes.

Each person is responsible for filling-out the appropriate information for the task performed. The next responsible person will not accept the data and SPF unless the data package is complete for what has been performed so far. In this way all necessary information concerning samples and all sample handling steps can be traced and noted in the report to the customer.

7.2.5.7 Subcontracting - Only in extremely rare occasions will BRL subcontract samples for analysis. This is done only with the prior consent of the client and the subcontractor laboratory must have an established and documented laboratory quality system that

complies with all of the requirements of the original contract. For example, if a project has been contracted under Department of Defense (DoD) Quality Systems Manual (QSM) requirements, then the subcontracted laboratory would have to meet the same requirements and also have DoD accreditation for all of the subcontracted analyses prior to analyzing any of the samples. In such a case, the documentation to transfer samples includes collection date and time (if available from the field samplers), the Field ID#, the BRL Lab ID #, the date of preparation (if extracts are transferred), and the requested analyses. Refer to section 5.4 for further discussion.

7.2.6 Sample Disposal

7.2.6.1 Sample Preparations – Unless otherwise specified in the contract, sample preparations may be disposed of once the preparations have been analyzed and the data has been reviewed and reported to the client. Additionally, sample preparations may be disposed of if the Laboratory Manager has determined that there is no further value in analyzing the preparations, such as water preparations for methyl mercury that are only stable for a maximum of two days. The disposal of each batch must be documented in the LIMS.

7.2.6.2 Original Samples – It is BRL policy to maintain all samples (aqueous and solid) for a minimum of two months after reporting results unless previous arrangements have been made with the client. At least once a year, all refrigerators and freezers should be cleared of any samples for which results have been reported more than two months ago. Samples that require longer storage should be separated from those that may be disposed after the two month period. The Sample Receiving Log in the LIMS must be updated to indicate that the samples have been disposed.

7.2.6.3 Disposal Guidelines – The concentration of all elements of interest in each sample preparation and each original sample is calculated to determine the proper disposal method for each sample (Refer to BRL SOP BR-0303 for disposal limits for specific elements). The method of disposal (routine verses high-level disposal) must be indicated on the appropriate form.

7.2.6.3.1 Routine Disposal

7.2.6.3.1.1 Water Samples and Acid Digestions - All water samples (including preparations) and acid digested solid samples that are not designated as being hazardous may be disposed down the drain. All acidic samples must be neutralized with Soda-Ash prior to disposal.

7.2.6.3.1.2 Native Solid Samples and Dry Weights - All native solid samples (not sample preparations) that are not designated as hazardous may be discarded directly into the garbage.

7.2.6.3.2 High Level Disposal - All High Level metal sample waste (as well as other waste that is considered to be hazardous) must be recorded in the Sample Receiving Log (original samples) or on the SPF (sample preparations). The total volume added to the High Level Waste containers must be logged in the "Waste Disposal Log."

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7.2.6.3.2.1 Water Samples and Acid Digestions - All water samples (including preparations) and acid digested solid samples that are designated as hazardous are placed directly into the high level metals/corrosives waste storage container.

7.2.6.3.2.2 Native Solid Samples and Dry Weights - All native solid samples (not sample preparations) that are designated as hazardous are disposed of directly into the hazardous waste container.

7.2.6.3.2.3 All Solvent Extracts - All solvent extracts must be treated as hazardous waste. Solvent extracts may be consolidated in clearly marked containers near the hazardous waste fume hood, and then disposed of as hazardous waste.

7.2.6.3.3 Non-Routine Disposal - Samples that are designated by the client to be high level in an analyte not performed by BRL shall be considered hazardous and treated as hazardous waste upon release for disposal. In certain cases, BRL may contract with a client to analyze samples that are known to be hazardous beyond the scope of our analysis (such as samples containing a high level of organic contaminants or dioxins), these samples will be flagged as requiring special disposal (as per the Laboratory Director's instruction) and disposed of through a licensed hazardous waste acceptance facility. BRL may also arrange with the client to return the leftover samples after analysis.

7.2.6.3.4 High-Level Metals Waste Transport and Ultimate Disposal - Once a sufficient volume of waste is generated, warranting proper disposal, a waste disposal company should be contacted, and the waste scheduled for pick-up. It shall be the responsibility of the waste handling company to transport and dispose of the high level metal waste in a manner consistent with local and federal environmental laws and regulations.

7.2.6.3.5 Low-level Radioactive Waste - All samples required to be disposed as low-level radioactive waste need to be in accordance with all local, state, and federal regulations regardless of the concentrations of other constituents. Current licensing at Brook Rand Labs does not allow for the storage or disposal of any waste above two times the background levels measured at Brooks Rand Labs.

7.2.6.4 Documentation – The LIMS is updated when necessary to both document disposal of samples (and sample preparations) and to initiate disposal or transfer of samples.

<Removed example Incident Report page – Refer to BRL SOP BR-1204 for discussion of incident reports>

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8.0 Analytical Procedures

8.1 Method References

Refer to the tables in section 6.0 for method number references and to Appendix A for a list of BRL analytical Standard Operating Procedures (SOPs).

8.2 Field Methods

Not Applicable. BRL is not currently involved in the analysis of samples directly in the field.

8.3 Analytical Method Modifications

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Methods BR-0006 and BR-0002 (Modifications of EPA Method 1631, Revision E and EPA Method 1631, appendix to) - EPA Method 1631.E describes the determination of mercury in ambient water while the Appendix to EPA Method 1631 describes the determination of mercury in solids. Any modifications that Brooks Rand Labs has made to these methods are fully documented in the appropriate SOP. All solid (biological, sediments and soils) matrices are prepared in accordance with SOP BR-0002, *BRL Procedure for EPA Method 1631, Appendix to (1/01): Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS)*. All aqueous matrices are prepared in accordance with SOP BR-0006, *BRL Procedure for EPA Method 1631, Revision E (8/02): Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)*. Please refer to the method validation package for SOPs BR-0002 and BR-0006 in Appendix C (available upon request).

Method BR-0011 (Modification to EPA Draft Method 1630) – BRL has developed a method for the determination of methyl mercury at the ultra-trace level in various matrices. The SOP for this method, BR-0011: *Determination of Methyl Mercury by Aqueous Phase Ethylation, Trapping Pre-Collection, Isothermal GC Separation and CVAFS Detection*, is included in Appendix B (available upon request). By this method waters are distilled to remove methyl mercury from the matrix. Alternatively, water samples may be extracted to remove methyl mercury from the matrix or analyzed by direct ethylation. Biological samples (i.e. animal and plant tissue) are digested in a KOH/Methanol solution. Sediment samples are extracted using dichloromethane. After sample preparation all samples are ethylated with tetraethyl borate which forms ethyl derivatives of the mercury species. The ethylated mercury species are collected on a Tenax® trap that is then introduced into the GC oven, pyrolytic column, and AFS detector. Under the flow of an inert carrier gas, the Tenax® trap is gently heated to release the mercury species, which are then separated chromatographically prior to being decomposed to elemental mercury (Hg^0), in the pyrolytic column. The AFS detector then detects Hg^0. Please refer to the method validation package for SOP BR-0011 in Appendix C (available upon request).

Method BR-0021 (Modification to EPA Draft Method 1632, Revision A) – BRL has developed a method for the determination of inorganic arsenic, trivalent arsenic,

monomethyl arsinic acid, and dimethyl arsinic acid at the trace level in various matrices. The SOP for this method, BR-0021: *BRL Procedure for EPA Method 1632, Revision A (1/01): Chemical Speciation of Arsenic in Water and Tissue by Hydride Generation Quartz Furnace Atomic Absorption Spectrometry*, is included in Appendix C (available upon request).

Method BR-0060 (Modification to EPA Methods 200.8, 1638, and 6020) –The SOP for this method, BR-0060: *Determination of Trace Elements by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) using a Perkin-Elmer ELAN DRC II*, is included in Appendix C (available upon request). Any modifications that Brooks Rand Labs has made to this method are fully documented in the SOP.

Methods BR-0063, BR-0066, and BR-0069 (Modification to EPA Method 1640) – The SOPs for these methods, BR-0063: *Determination of Trace Elements in Seawaters and Low Level Waters by Online Column Chelation Preconcentration – Inductively Coupled Plasma – Mass Spectrometry using a Perkin-Elmer ELAN DRC II*, BR-0066: *Reductive Precipitation of Total recoverable and Dissolved Metals from Brackish and Seawater Samples* and BR-0069: *Extraction Using Co-APDC for Nickel, Copper, Silver, Cadmium, and Lead in Water*, are included in Appendix C (available upon request). Any modifications that Brooks Rand Labs has made to this method are fully documented in the SOPs. Modifications to the analysis of samples are documented in BR-0060: *Determination of Trace Elements by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) using a Perkin-Elmer ELAN DRC II.*

Method BR-0080 (Modification to SM 3500 – Fe B) – The SOP for this method, BR-0080: *Determination of Iron Speciation in Water Samples by Colorimetric Detection*, is included in Appendix C (available upon request).

Method BR-0085 (Modification to EPA Methods SW 3060A and SW 7196A) – The SOP for this method, BR-0085: *Determination of Hexavalent Chromium (Cr^{6+}) in Sediment and Aqueous Samples* is included in Appendix C (available upon request).

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8.4 Laboratory Operations

8.4.1 Laboratory Glassware

All glassware for ultra-trace metals analysis must be rigorously cleaned, in order to minimize possible contamination. Glassware is initially cleaned using Alconox® and DIW and scrubbing with a brush. After thorough rinsing with DIW, the glassware is immersed into either a large rectangular vat containing 50% HCl or one containing 50% HNO_3, depending on how great the concentration of analyte in the glassware was prior to cleaning. Each of these acid vats is equipped with an immersion heater and a calibrated voltage regulator, or Variac). After filling the vat with glassware, the Variac and heater are turned on to heat the vat to 75°C and the samples are soaked for a period of 48 hours. Glassware to be used for ICP-MS analyses is stored in the cold 30% nitric acid vats.

Glassware for certain parameters other than ultra-trace metals need only be cleaned with Alconox and DIW followed by copious rinsing with DIW. A detailed account of the decontamination procedures for laboratory glassware is described in SOP BR-0402.

8.4.2 Reagent Storage

All supplies (i.e., glassware, chemicals, and reagents) are of the highest possible quality to ensure quality assurance and to avoid contamination. Reagents purchased from commercial vendors are labeled with the date received, the date opened, and the expiration date. Reagents used for stock and working standards are prepared from analytical reagent grade chemicals or higher purity grades, unless such purity is not available. Reagent water is prepared by deionization of city water using reverse osmosis. Each prepared reagent is clearly labeled with the composition, concentration, date prepared, initials of preparer, expiration date, BRL lot # and special storage requirements, if any.

Reagent water used in the laboratory is produced by reverse osmosis. The level of mercury in the reagent water is less than 0.2 ng/L and is checked during mercury analyses. Reagent water is tested monthly for ICP-MS metals at each sink used to clean bottles, prepare samples/reagents, or analyze samples. The reagent water is at metal concentrations below the method reporting limits (MRL) for each metal. If reagent water fails to meet the criteria for any metal, then the water may not be used for analysis of the metal until reagent water blanks have met the criteria.

Reagent solutions are stored in appropriate glass or plastic containers under conditions designed to maintain their integrity (refrigerated, dark, etc.). Shelf life is listed on the label, and the reagent is discarded after it has expired. Acids used are either glass-distilled or analytical reagent grade for trace metal analysis. Reagent solutions are checked for contamination by testing reagent blanks before use.

Refer to BRL's Chemical Hygiene Plan for a list of all chemicals used at BRL. The aforementioned document also describes where and how these chemicals are stored at BRL. Material Safety and Data Sheets (MSDS) are stored on the server as PDF files and should be consulted for detail concerning potential hazards associated with specific chemicals. MSDSs are organized on the server by both chemical name and by CAS number. BRL SOP BR-0500 describes the documentation of standards and reagents in the LIMS and the testing of standards and reagents.

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8.4.3 Waste Disposal

Handling, storage, and disposal of laboratory-related hazardous wastes are subject to the regulations contained in the Resource Conservation and Recovery Act. BRL shall store, package, label, ship, and dispose of hazardous wastes in a manner which ensures compliance with all federal, state, and local laws. Potentially hazardous wastes include all standards, reagent solutions, process wastes, solvents, native samples, sample extracts, and digestates.

A waste is considered hazardous if:

1. The waste material is listed as hazardous in 40 CFR Part 261.30-261.33.
2. The material exhibits any of the characteristics of hazardous waste: ignitability, corrosiveness, reactivity, or EP toxicity.
3. The waste is listed in 1 or 2 above and is not excluded by any provisions under the Resource Conservation and Recovery Act.

A waste is considered an acute hazardous waste if it is identified in 40 CFR Part 261.31, 261.32, 261.33 (e) as an acute hazardous waste.

BRL is categorized as a Large Quantity Generator. This category is defined as: A generator who generates at least 1000 kilograms of hazardous waste or 1 kilogram of acute hazardous waste in a calendar month and stores all generated waste for no more than 90 days (40 CFR Part 261.5).

BRL shall ensure delivery of hazardous waste to a treatment, storage, or disposal facility, which is:

1. Permitted under 40 CFR Part 270
2. In the interim status under 40 CFR Parts 270 and 265
3. Authorized to manage hazardous waste by a state with a hazardous waste management program approved under Part 271; or
4. Permitted, licensed, or registered by a state to manage municipal or industrial solid waste (subject to local regulations).

Hazardous waste solvents as identified in the 40 CFR Part 261 may not be evaporated off in a fume hood. Solvents evaporated off during the extraction/testing process are exempt. Acidic and basic wastes may be neutralized and disposed of via the sanitary sewer if they are not hazardous due to the presence of other constituents (as subject to local regulations). Heavy metals may be precipitated from the liquid portion and disposed via the sanitary sewer (subject to local regulations).

Hazardous waste storage is limited to quantity and/or accumulation time and must comply with RCRA regulations as specified in the 40 CFR. These wastes should be packaged and separated according to the compatible groups (e.g. solvents, acids etc.).

Samples submitted to BRL for analysis are excluded from regulation as hazardous waste under 40 CFR Part 261.4(d) provided the samples are being transported to or from the laboratory, are being analyzed, are being held for analysis or are being maintained in custody for legal reasons. However, once a decision is made to dispose of the laboratory samples, the exclusion provisions of 40 CFR Part 261.4(d) no longer apply. Samples that have been identified as hazardous may be either: 1) returned to the generator; or, 2) disposed of according to applicable Resource Conservation and Recovery Act (RCRA) regulations. Samples, which are determined to be non-hazardous, may be subject to local environmental regulations. A sample collector shipping sample to a laboratory and a laboratory returning samples to a sample collector must comply with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or any other applicable shipping requirements.

Native samples and sample preparations must be disposed of in accordance with local, state, and federal regulations. Residual native samples must be separated by matrix (water, sediment/soil, and biota) and placed in the appropriate containers for disposal. Remaining sample preparation solutions must be separated by digestion type (acid, base, solvent extract) and placed in the appropriately labeled disposal containers.

8.4.4 Laboratory Procedures

BRL currently has one clean room for ultra-trace mercury analysis and a semi-clean room for other trace metal analyses.

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The mercury laboratory, prep laboratory, receiving laboratory, bottle washing and sample storage areas are monitored monthly for atmospheric mercury levels to ensure that levels are suitably low for ultra-trace level mercury analysis. A warning level has been established at 15 ng/m^3 with a shutdown control level at 25 ng/m^3. Reagent water is tested for mercury each day prior to beginning analysis by testing bubbler blanks. The average bubbler blank must contain less than 20 pg Hg. Clean room sticky mats are located at the entrance to minimize tracking in particles.

The AA / ICP-MS lab is where other metals analyses are conducted. This lab contains two laminar flow hoods with HEPA filters. Incoming air is pre-filtered. The laminar flow hood is at one end of the room with the air intake at the other to facilitate efficient circulation through the HEPA-filter. In addition, the entrance to this lab has an enclosed gowning area to reduce direct flow from outside air. Reagent water is tested by ICP-MS at least once a month. Clean room sticky mats are located at the entrance to minimize tracking in particles.

8.5 Exceptional Departures from Standard Operating Procedures (SOPs)

The QA Officer, Lab Manager, and/or the Vice President of Analytical Services must approve of any departure from BRL standard operating procedures. Under no circumstances is the Sample Preparation Technician or the Analyst authorized to alter any standard procedure without managerial approval. Such approval and the actual departure from BRL procedure must be fully documented and conveyed to the affected client. All quality control criteria must still be met for all reported data.

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9.0 Calibration Procedures

9.1 Instrumentation List

TABLE 9.1 - INSTRUMENTATION LIST

Description	Manufacturer	Model #	Unique ID#	In Service Date
Analyzers				
CVAFS Hg Detector	BRL	III	BR-05	03/12/02
CVAFS Hg Detector	BRL	III	BR-06	03/07/02
CVAFS Hg Detector	BRL	III	BR-09	08/06/03
CVAFS Hg Detector	BRL	III	BR-10	05/10/04
CVAFS THg Auto Analyzer	BRL	Merx-T	Merx-T	05/10
CVAFS MeHg Auto Analyzer (GC Unit)	BRL	Merx	Beta	06/07
CVAFS MeHg Auto Analyzer (Purge & Trap Unit)	BRL	Merx	Merx-1	06/09
ICP-MS	Perkin Elmer	ELAN DRC II	Ellie Z1300410	01/04/05
ICP-MS	Perkin Elmer	ELAN DRC II	Darcy AI13200711	11/08
Auto Sampler	ESI	SC-4 w/FAST	Jack Rack'em FST04-080606	05/08
Auto Sampler	ESI	SC-4 w/FAST	FST04-081012	11/08
HPLC Auto Sampler Thermal Compartment	DIONEX	ICS Series	 11010036 10120774	 01/11 01/11
Flame AAS	Buck Scientific	Buck 205	112	10/03/05
ICP-MS Chiller	Polyscience	3370	108400314	10/08
Colorimetric Spectrophotometer	Thermo - Scientific	Evolution 60S	2R1P203001	05/11
Digestion Equipment				
Microwave oven	BERGHOF	SPEEDWAVE	000262	04/11
Sonicator	Branson	1510R-MT	RKA090407117D	04/11
Distillation Blocks (total = 5)	BRL	DI-02	NA	Latest 09/10
Hot Block Digester	BRL	LINX	GFD 1009102	01/11
Hot Block Digester	Environmental Express	SC100	2932CEC1445	09/04
Hot Block Digester	Environmental Express	SC154	4667CEC2213	09/04
Water Bath	Blue M	MW-1120A-1	M5-8717	Prior to 2000
Centrifuge	Eppendorf	5810	0012951	04/08

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TABLE 9.1 INSTRUMENT LIST (CONTINUED)

Description	Manufacturer	Model #	Unique ID#	In Service Date
Hot Plates (total = 4)	Various	NA	NA	09/04
Balances				
Top Loading (to 0.1 mg)	Mettler Toledo	AL54	1226280324	06/06
Top Loading (to 1 mg)	Sartorius	E1200	39010004	Prior to 2000
Top Loading (to 1 mg)	Ohaus	AR1530	H171 12031 20715 P	01/04
Top Loading (to 10 mg)	Ohaus	SP602	7126020087	10/04
Top Loading (to 10 mg)	Ohaus	SP402	7123210873	10/04
Ovens				
Scientific Oven	Blue M	OV-490A-2	JT-1800 (BR-01)	06/10/02
Scientific Oven	Fisher Scientific	630F	BR-02	Prior to 2000
Scientific Oven	Blue M	SW-17TA-1	SW-1881 (BR-03)	10/04
Scientific Oven	Fisher Scientific	650G	502N0046 (BR-04)	03/05
Scientific Oven	Thermo Prec.	6567	602428	03/08
Muffle Furnace	Isotemp	550-58	1510060889906	2006
Refrigerators/Freezers				
Walk-In Refrigerator/ Freezer Unit	Easton Refrigeration	Various Units Combined	Walk-In	12/08
Chest Freezer	General Electric	CB22DL	RA180154	Prior to 2000
Chest Freezer	General Electric	FCM7SUAWW	GR274463	07/08
Chest Freezer	Frigidaire	FFC15C4CW0	WB40945673	01/05
Chest Freezer	Frigidaire	GLFC2027FW5	WB81135168	07/08
DIW System				
Reverse Osmosis Deionized Water System	US Filter (Serviced by Siemens)	ROSLW1003	9001-756	Updated to 500 gallon capacity 08/15/05
Conductivity/pH Meters				
pH/Conductivity/TDS/ Temperature Meter	Oakton	pH/CON 510 series	162259	01/27/05
Salinity Meter	Oakton	SALT 6, Acorn series	328917	03/08

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9.2 Standard Receipt and Traceability

All stock standard solutions are received by the analytical laboratory and are documented in the LIMS. Information documented in the LIMS includes source, type of standard, date of receipt, lot number (if applicable), and expiration date. PDF copies of stock standard certificates are attached to the LIMS standard page for the standard. Original certifications for all stock standards are maintained in a designated binder located in the main office area.

All standard solutions are stored in a manner that is consistent with the manufacturers' recommendations.

Standards traceability is achieved by documenting all standard solution information in the LIMS. In addition to the previously mentioned documentation for stock standards, documentation for intermediate standard solutions must include: identification of primary (stock) standard used, the preparation date, method of preparation (specifically dilution information), the preparer's name, the concentration prepared, BRL lot #, and the expiration date. Documentation for working standards must include: identification of the stock and intermediate standards used, the preparation date, method of preparation (specifically dilution information), the preparer's name, the concentration prepared, BRL lot #, and the expiration date.

9.3 Standard Sources, Preparation, and Testing

All working standards are documented for traceability as discussed in section 9.2. All intermediate and working standards are made in accordance with the protocols of the specific procedure for which the standards shall be used. Refer to Table 9.3 and/or the analytical method or SOP for the specific procedures followed for the preparation of any intermediate or working standard.

Any new standard must be tested prior to use. The acceptance criterion is that the average recovery of the new standard is within ± 5% of the average recovery of the previous standard. A minimum of three replicates of the old and the new standard must be analyzed for comparison. The RSD of the measurements of each standard may not exceed 5.0%. Standards that are made daily are not tested against the old standard prior to use. Instead, they are verified against the second source standard.

Quality control reference materials are currently acquired from the National Resource Council of Canada (NRCC), the National Institute of Standards and Technology (NIST), the International Atomic Energy Agency (IAEA), or Community Bureau of Reference (BCR).

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TABLE 9.3 - STANDARD SOURCES AND PREPARATION

Instrument Group	Standard Source(s)	How Received	Storage	Preparation from Source	Lab Storage	Preparation Frequency
Atomic Fluorescence	Total Hg – High Purity Standards (calibration)	Solutions of 1000 µg/mL	Room temp. 2% HNO_3	Intermediate standards are prepared from Stock standard	10000 ng/mL, 2% BrCl at 4 °C	annually
				Intermediate standards are prepared from Stock standard	1000 ng/mL, 2% BrCl at 4 °C	annually
				Working standards are prepared from intermediate	10ng/mL & 1 ng/mL, 1% BrCl at room temperature	monthly
	NIST 1641d (independent check)	CRM Solution of 1601 µg/mL	4 °C; 2% HNO_3	Verification standards are prepared from a source other than the calibration standards	1.601 ng/mL, 1% BrCl at room temperature	monthly
Atomic Fluorescence	Methyl Hg – Strem Chemicals, Alfa Aesar, or Environmental Resource Associates	Solutions of ~ 2000 ppm MeHg	Room temp. in the dark	Intermediate standards are prepared from stock standard	1000 ng/mL, 0.2% HCl 0.5% HOAc in dark at 4 °C	annually
				Working standards are prepared from intermediate	1 ng/mL & 10 ng/mL, 0.2% HCl 0.5% HOAc in dark	monthly
	DORM-3 (Fish Homogenate)	Solid CRM 355 ng/g	Room temp. in desiccator	~90-100 mg of CRM into 10 mL of KOH/methanol and diluted to 40 mL with methanol; final concentration of 0.8-0.9 ng/mL	Room temp. in the dark	monthly

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TABLE 9.3 - STANDARD SOURCES AND PREPARATION (CONTINUED)

Instrument Group	Standard Source(s)	How Received	Storage	Preparation from Source	Lab Storage	Preparation Frequency
ICP-MS	Single-Element High Purity Standards	Solutions of 1000 or 10000 ppm	Room temp. in the dark	Intermediate standards are prepared from Stock standards	Plastic cabinet under TM clean hood, 2% nitric	semi-annually
				Working standards are prepared from intermediate	Plastic cabinet under TM clean hood, 2% nitric	daily/ as needed
	Multi-Element CPI International (independent check)	Various conc. Depending on element	Room temp. in the dark	1000x dilution working standard	Clean hood of ICP-MS room, 2% nitric	semi-annually / as needed
				4x dilution prepared from intermediate	Clean hood of ICP-MS room, 2% nitric	monthly / as needed
	NIST 1643e National Institute of Standards and Technology	Various conc. Depending on element	Room temp. in the dark	5x dilution at the instrument	Not stored	made daily

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TABLE 9.3 - STANDARD SOURCES AND PREPARATION (CONTINUED)

Instrument Group	Standard Source(s)	How Received	Storage	Preparation from Source	Lab Storage	Preparation Frequency
HPLC-DRC-ICP-MS	Se(IV) Spex Certi Prep	Solutions of 1000 ppm	Fridge 0-4 °C	Intermediate standards are prepared from Stock standards	Not stored	made daily
	Se(VI) High Purity Standards	Solutions of 1000 ppm	Fridge 0-4 °C	Intermediate standards are prepared from Stock standards	Not stored	made daily
	Se (species) Inorganic Ventures (independent check)	Solutions of 1000 ppm	Fridge 0-4 °C	Intermediate standards are prepared from Stock standards	Not stored	made daily
Atomic Absorption	As (species) High Purity Standards	Solutions of 1000 ppm	Fridge 0-4 °C	Working Standard are prepared from stock standards	Fridge 0-4 °C	monthly
	As (species) Lab Chem (independent check)	Solutions of 1000 ppm	Fridge 0-4 °C	Working Standard are prepared from stock standards	Fridge 0-4 °C	monthly
pH Meters	Scientific Products	pH 4, 7, 10	Room temp.	NA	NA	NA
Conductivity Meters	Fisher Scientific	Solutions of 9.77 µmhos 96 µmhos and 974 µmhos	Room temp.	NA	NA	NA

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9.4 Instrument Calibration

The analytical methods or the SOP for the specific method specifies all calibration protocols, frequency and acceptance criteria. Full documentation for calibration is included in the sample data. In addition, each instrument has a log book in which summarized information is documented. This summarized documentation includes date, analyst, batch #, calibration coefficient (or response factor), correlation coefficient (r), average blank level, and instrument noise level or other relevant instrument information. In addition, any instrument maintenance is documented in the instrument log books.

9.4.1 CVAFS, HGAAS, and ICP-MS Instrument and Method Calibration

Instrument abbreviations are as follows: Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS), Hydride Generation Atomic Absorption (HGAAS), and Inductively Coupled Plasma – Mass Spectrometry (ICP-MS). Each instrument used to analyze samples must pass the calibration criteria established in the appropriate method or operating procedure. The instrument calibration consists of analyzing a minimum of three standards (HGAAS and ICP-MS) covering at least one order of magnitude (one at the low end, one in the middle and one high standard below the upper limits of linearity within the calibration curve) and a calibration blank (Note: A minimum of five standards must be used in the calibration for all CVAFS work). These standards should span the linear range of the instrument. The correlation coefficient (r) of the initial calibration for ICP-MS must be ≥ 0.995. If the squared correlation coefficient (r^2) is calculated for the ICP-MS calibration, then r^2 must be ≥ 0.990. For CVAFS the RSD of the calibration coefficients must be $\leq 15\%$ and for HGAAS the RSD of the calibration coefficients must be $\leq 20\%$. The initial calibration check, consisting of one standard at the mid-point of the calibration curve and one calibration blank, is performed immediately following this calibration. Continuing calibration verification standards are analyzed at the end of each batch or sequence and, depending on the analytical method, at a frequency of 10% during the course of the analytical sequence. Initial and continuing calibration checks are used to establish whether ongoing instrument calibration is acceptable. The calibration is verified with a standard prepared from a source independent of the calibration standards.

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When calibrating the instrument, the low calibration standard must be equal to or less than the method reporting limit (MRL). Standards may be removed from the bottom end or top end of the calibration when they do not meet acceptance criteria as long as at least three consecutive standards remain, however, this will result in a reduced range of quantitation. It is never permissible to drop a mid-level point from the calibration without also dropping either all of the points below or all of the points above it as well. Results should not be reported if the instrument result for the sample is above the result for the high calibration standard. It is standard practice to dilute the high-level sample and reanalyze it such that the result at the instrument falls within the calibration. A result that is outside of the calibration range would not be reported without appropriate qualification or explanation.

It is standard procedure at Brooks Rand Labs to calibrate analytical instruments daily prior to analyzing any client samples. Under certain circumstances further analysis of samples may be

reinitiated without recalibrating the instrument. If this is to be done for any reason, the following procedures must take place prior to the analysis of any blanks or client samples:

1) Less than 12 hours must have passed since the calibration was last verified
2) The Laboratory Manager, the QA Manager, or specific Group Lead must approve of the deviation from standard BRL procedure and document the approval on the SPF
3) Both an ICV and a CCV must be run to verify the calibration
4) Either the QA Manager or the Group Lead must approve of the calibration verification results prior to beginning to analyze samples

All standards used to prepare the calibration standard solution are obtained from chemical suppliers and are of high purity and concentration. The standards are routinely checked by the laboratory for traceability to National Research Council of Canada (NRCC) or National Institute of Standards and Technology (NIST) Standard Reference materials. These commercial standards are used as stock standards. Working standards are made from the stock standards at appropriate concentrations to cover the linear range of the calibration curve as outlined in the individual procedures. Preparation of all standards is recorded in the LIMS (as described in SOP BR-0500). All solutions are labeled as follows: name of solution, concentration of solution, date prepared, LIMS ID number, expiration date, and analyst's initials. All laboratory analysis (including instrument calibration) is documented by the analyst on the analytical bench sheets. All information concerning the calibration must be stored such that the calibration can be recreated if need be.

9.4.2 Periodic Calibration Procedures for other Laboratory Equipment

Periodic calibration checks are performed for associated equipment such as balances, thermometers, ovens, and refrigerators that are required in analytical methods but that are not routinely calibrated as part of the analytical procedure. All the calibration measurements are recorded in a laboratory log book as outlined in SOP BR-1200.

BALANCES

Balances are calibrated annually by a contracted, certified professional. Balances are also checked with Class S weights on a daily or as-used basis. At the beginning of each day that the balance is used, the analyst is required to perform at least one calibration check in the range of the material to be weighed. All calibration checks are documented in a laboratory log book. All weights used to calibrate balances on a daily basis are themselves calibrated at a minimum every 5 years against NIST traceable weights.

TABLE 9.4 - CRITERIA FOR BALANCE CALIBRATION CHECKS
4-POINT BALANCE

Class S / 1 Weight (g)	Warning Level (g)	Control Level (g)
0.0100	0.0099 - 0.0101	0.0098 - 0.0102
0.1000	0.0997 - 0.1003	0.0995 - 0.1005
1.0000	0.9995 - 1.0005	0.9990 - 1.0010
10.0000	9.9950 - 10.0050	9.9900 - 10.0100
100.0000	99.9500 - 100.0500	99.9000 - 100.1000

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3-POINT BALANCE

Class S / 1 Weight (g)	Warning Level (g)	Control Level (g)
0.100	0.099 - 0.101	0.098 - 0.102
1.000	0.995 - 1.005	0.990 - 1.010
10.000	9.950 - 10.050	9.900 - 10.100
100.000	99.750 - 100.250	99.500 - 100.500

TOP LOADING BALANCES

Class S / 1 Weight (g)	Warning Level (g)	Control Level (g)
1.00	0.99 - 1.01	0.98 - 1.02
10.00	9.95 - 10.05	9.90 - 10.10
100.00	99.5 - 100.50	99.00 - 101.00
200.00	199.00 - 201.00	198.00 - 202.00

PIPETTES

All pipettes are calibrated weekly. Pipettes performance is monitored by gravimetrically measuring the volume of DIW dispensed by each pipette over the range of its use prior to calibration with the assumption that the density of the water in the laboratory is 1.000 g/mL (± 0.003 g/mL). The volume dispensed by each pipette is then re-measured after calibration and both measurements are maintained in a laboratory log book. Bias and precision are measured for all new pipettes prior to being put into service and then monthly thereafter. Bias and precision are based on 10 measurements. The criteria are that the average measurement must be within ± 2% of the measured volume and the RSD of the measurements must be ≤ 1%.

OVENS, HOTPLATES, SAND BATHS, WATER BATHS, REFRIGERATORS, AND FREEZERS

Temperatures are checked with calibrated thermometers and necessary adjustments to the temperature settings are made as required. Refrigerators and freezers are checked on a daily basis and all ovens, hotplates, sand baths, and water baths are checked at least once during each use. Refrigerator and freezer temperatures are recorded in laboratory logs that are maintained by the Sample Control Group Lead. Oven, hotplate, sand bath, and water bath temperature are recorded in the sample preparation logs.

THERMOMETERS

The performance of each thermometer is compared annually to a certified NIST-grade thermometer and correction factors are posted for each thermometer in the area where it is used.

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10.0 Preventative Maintenance

10.1 Routine Maintenance Measures

Refer to SOP BR-1205 (Preventative Maintenance) for greater detail of specific procedures.

TABLE 10.1 - PREVENTATIVE MAINTENANCE

Instrument	Activity	Frequency
ICP-MS	Inspect and/or change all tubing	Daily
	Clean sampler and skimmer cones	Daily
	Inspect torch and injector	Daily
	Check gas and coolant levels	Daily
	Change roughing pump oil	Monthly*
	Update mass calibration (tuning)	Monthly
	Replace quartz torch and injector	Semi-Annually*
	Replace sampler and skimmer cones	Semi-Annually*
	Replace RF coil	Semi-Annually*
	Replace chiller air filter	Annually*
	Replace ion lens	Annually*
	Schedule annual maintenance with Perkin-Elmer	Annually
HPLC	Change eluents	Daily
	Inspect lines for leaks and obstructions	Daily
	Monitor suppressor flow	Daily
	Clean and regenerate suppressor	Monthly*
	Clean and test analytical column	Monthly*
CVAFS (Total Hg)	Prepare new soda lime pre-traps	Daily
	Condition bubblers and blank traps	Daily
	Check all fittings	Daily
	Soak bubblers for 15 minutes in 1% KOH and then over the weekend with 10% HCl	Weekly*
	Inspect and/or change all tubing	Monthly*
	Make, test, and change out traps	Quarterly*
	Change lamp	Semi-Annually*
	Blank traps on incoming gas lines	Semi-Annually*
	Clean/change quartz cell	Annually*
	Check Electronics	Annually

* or as needed

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TABLE 10.1 - PREVENTATIVE MAINTENANCE (CONTINUED)

Instrument	Activity	Frequency
CVAFS	Prepare new soda lime pre-traps	Daily
(MERX-T)	Check all tubing and clear any liquid in tubing	Daily
	Inspect and/or change all tubing	Monthly*
	Change Traps	Semi-Annually*
	Change lamp	Semi-Annually*
	Change traps on incoming gas lines	Semi-Annually*
	Clean/change quartz cell	Annually*
CVAFS	Inspect and/or change all tubing	Monthly*
(MeHg)	Condition GC column at 80 °C overnight	Quarterly*
	Change lamp	Semi-Annually*
	Check and change out traps	Semi-Annually*
	Blank traps on incoming gas lines	Semi-Annually*
	Clean/change quartz cell	Annually*
	Replace GC column	Annually
AA - Flame	Check tubing, pump and lamps	Daily
	Rinse water removal trap with DIW	Daily*
	Clean spectrophotometer windows	Weekly
	Soak bubblers over weekend in 30% nitric acid	Monthly*
	Inspect and/or change all tubing	Monthly*
	Clean nebulizer	Semi-Annually
	Fine tune the instrument wavelength	Annually*
	Check instrument optics	Annually*
Colorimetric /	Clean sample compartment	Daily
Spectrophotometer	Windows cleaned	Monthly
	Check Electronics and lamp alignment	Annually
pH Meter	Clean; 2 pt. Calibration	After each use
Balances	Clean pans and compartment	Before and after every use
	3 to 4 pt. Calibration check	Before every use
	Certified Calibration	Annually
Pipettes	Full calibration over entire range of pipette	Weekly*
Conductivity Meter	Check batteries and probe cables	Weekly*
Refrigerator /	Check temperature	Daily
Freezers	Clean interior	Monthly*
	Check temperature against NIST certified thermometer	Annually

* or as needed

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10.1.1 Air Testing

The mercury lab, the sample preparation lab, the receiving laboratory, bottle washing, and the trace metals lab are monitored monthly for atmospheric mercury levels to ensure that these levels are sufficiently low for ultra-trace level mercury analysis. Air from each lab is pumped through a soda lime pre-trap and onto either a gold wire or gold-coated sand trap at a flow rate of 1 L/min until at least 20 L of air have been collected per trap. A warning level has been established at 15 ng Hg/m^3 with a shutdown control level at 25 ng Hg/m^3. Results from the monthly air tests are electronically on the server.

10.1.2 Water Testing

Reagent water is monitored for Hg on a daily basis when calibration blanks are analyzed. A minimum of four 100 mL aliquot of fresh reagent water, each with 0.5 mL $NH_2OH{\cdot}HCl$ and 0.5 mL of $SnCl_2$, are analyzed at the beginning of the run sequence. The average results must be < 25 pg Hg with a standard deviation < 10 pg Hg. A high level of mercury detected in the reagent water analysis may also be attributed to the bubbler itself, the $SnCl_2$, or the soda lime pre-traps. Regardless of the source, all analysis is stopped until the source of contamination is determined and the problem is corrected. The results are stored with each batch.

Reagent water is tested for trace metals by ICP-MS at a minimum of once per month when instrument water blanks collected from every sink used to clean equipment, prepare reagents/samples, or analyze samples are analyzed. Specific elements are tested for with each batch. Currently, water blanks must be less than the element specific MRL or client specific requirements. Results for water testing are stored on the server in Excel© spreadsheets.

10.1.3 Equipment and Reagent Testing

All reagents (acids, standards, etc.) and equipment (bottles, vials, etc.) are tested prior to use. The acceptance criteria for specific reagents and equipment are specified in the individual SOPs describing the use of the reagents or the decontamination of equipment. In all cases, contract specified requirements take precedence over BRL acceptance criteria.

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10.2 Documentation

Instrument logbooks are maintained for all equipment. These logbooks contain a complete history of past performance and maintenance. For each CVAFS and AA instrument, a logbook is kept to document instrument usage, routine maintenance, and non-routine repairs.

10.3 Contingency Plans

10.3.1 Major Equipment Failure

For major equipment failure of CVAFS instruments, the laboratory has backup instrumentation. BRL is an instrument manufacturer specializing in ultra-trace level mercury analyzers; therefore, a stock of replacement parts and complete analyzers exist and expert service personnel are readily available.

For flame AA's, rental equipment is locally available in the case of a major equipment failure while instrumentation is being repaired.

For the ICP-MS, BRL has two Perkin Elmer ICP-MS instruments. Perkin Elmer's service record is excellent, and none of our ICP-MS instruments has ever been out of service for more than 1 week.

BRL currently has an excess of balances and refrigerators/freezers. If any of this equipment fails backup equipment is immediately available. Other equipment such as the conductivity meter and the pH meter are relatively inexpensive and will be purchased immediately if major equipment failure is determined.

10.3.2 Invalidation of work

Results for all sample analyses affected by equipment failure may be ruled invalid depending upon the circumstances. When QC criteria are not met during analysis, all instrumentation is thoroughly checked and appropriate maintenance action is taken. Subsequent reanalysis of the affected samples is then initiated after the instrumentation is proven to be functioning properly. The QA Manager and the Lab Manager have the authority to stop work whenever there is evidence of non-conforming work. Once work is stopped, corrective action must take place and be documented. Permission to restart work must be granted by the QA Manager or the Lab Manager.

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11.0 Quality Control Checks and Routines to Assess Precision and Accuracy and the Calculation of Method Detection Limits

The laboratory uses quality control samples to assist in assessing the validity of the analytical results of field samples. The use of quality control samples helps to assess analytical accuracy and precision in the laboratory. Quality control samples are analyzed in the same manner as field samples at a frequency described either in the individual procedures or in the contract with the client. If the quality control sample results fall within acceptable criteria (also detailed in the method), then the field sample data are considered to be valid or acceptable as is. However, it is important to keep in mind that errors made during sample collection can seriously affect the analytical results of field samples. In other words, the quality or validity of the field sample data is only partially supported by the laboratory quality control sample results. Field quality control samples are the other necessary component for the validity of field sample results.

Laboratory quality control (QC) samples include method blanks, calibration checks, replicates, spiked samples, and certified reference materials (CRM). The specific frequency and type of QC samples analyzed are described in the individual analytical method, SOP, or client-specific Statement of Work (SOW). In some cases, contracts may specify additional or more stringent QC requirements beyond what the method requires. In these cases the contract specific QC requirements are followed. In addition to these routine QC samples, performance evaluation samples required for state certification are analyzed semi-annually.

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11.1 Quality Control Checks

11.1.1 Field QC Checks

Brooks Rand Labs is rarely involved in field sampling. The client is typically responsible for field sampling activities and therefore mandates the requirements for field QC checks. However, BRL suggests that the following field QC be collected.

11.1.1.1 Trip Blanks

Trip blanks are used to demonstrate that sampling equipment and collected samples have not been contaminated during transit. Trip blanks consist of laboratory reagent water collected into a sampling container at the laboratory. The trip blank is then double bagged (as per sampling containers for use in the field) and affixed with a custody seal to indicate if it has been tampered with. The trip blank is then shipped with the sampling kit to and from the field. The trip blank must not be opened again until it has returned to the laboratory.

When collected and analyzed, the level of the analyte of interest in the trip blank should be less than the reporting limits or less than 10% of any affected sample results. If criteria are not met, then the client must be notified and every effort should be made to determine the source of the contamination and to eliminate it if possible.

11.1.1.2 Field Blanks

Field blanks are used to demonstrate that the samples were not contaminated during the collection procedure or while in transit (Note: The analysis of trip blanks in conjunction

with field blanks can better pinpoint the source of contamination). Field blanks are collected in the field, typically using lab-supplied reagent water, and simulating the collection of actual samples as well as can be done. Once collected, the field blank is treated in every way as an actual sample.

When collected and analyzed, the level of the analyte of interest in the field blank should be less than the reporting limits or less than 10% of any affected sample results. If criteria are not met, then the client must be notified and every effort should be made to determine the source of the contamination and to eliminate it if possible.

Many methods require that field blanks be collected and analyzed if results are to be reported for regulatory purposes. While Brooks Rand Labs does not require that clients provide field blanks for analysis, BRL does inform clients of this regulatory requirement in the quote signed by the client prior to any work performed as well as in any case narrative that includes relevant results.

11.1.1.3 Field Duplicates

Field duplicates are used to assess precision in the collection procedures. When collected, the field duplicate relative percent difference (RPD) should be no greater than that allowed for method duplicates by the specific analytical method, the SOP, or the SOW. If the RPD is greater than the acceptance criterion, then the sampling team should be notified. When analyzed in conjunction with method duplicates (Section 11.1.2.7), field duplicates will aid in determining the source of any imprecision.

11.1.2 Lab QC Checks

11.1.2.1 Method Blanks

A method blank is a sample of reagent water treated as a sample such that it is prepared in conjunction with and undergoes the same analytical processes (i.e. same reagents added in equivalent amounts, digested in the same type container at the same temperatures/times, etc.) as the corresponding field samples. Method blanks are used to monitor laboratory performance and contamination introduced during sample preparation and analysis. The method blank minimum frequency and acceptance criteria are method specific (Refer to specific SOP). Also refer to the specific analytical method, the SOP, or the contractual requirements.

In cases where a sufficient number of method blanks (minimum of four) have been prepared and analyzed with the batch to characterize the nature of the blanks and the potential for any reagent or spot contamination, one blank may be rejected as a Grubb's Outlier if it meets the criteria for doing so at the 5% or less risk of false rejection level (refer to Section 11.2.2 for further discussion on how the Grubb's Test for Outliers is applied to data). If a method blank is rejected as a Grubb's Outlier, then its value is not used to calculate the mean or the standard deviation of the method blanks used to blank-correct the batch data. If no spot contamination is evident in the batch (e.g. elevated trip or field blanks, random dissolved results significantly greater than total results), then the rejected method blank is not considered when evaluating the rest of the data. However, if there is evidence of additional spot contamination, then the data is evaluated against the method blank considered to be a

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Grubb's Outlier such that any data point not ≥ 10 times the rejected method blank would require reanalysis or appropriate qualification.

Note: Some projects do not allow for the rejection of any method blank, such as those under the DoD QSM 4.2. For such projects the Grubb's Outlier method blank is still not used to correct the results, but all results are judged against the Grubb's Outlier as described above regardless of whether there is any further evidence of spot contamination in the batch or not.

The discarding of any data point as a Grubb's Outlier and the potential affect on overall data quality must be narrated to the client. Current LIMS limitations do not allow method blanks rejected as Grubb's Outliers to appear on the "Method Blanks & Reporting Limits" page of the report. Therefore, the value of any rejected method blank must be reported in the case narrative section of the data report. Grubb's Outliers may never be discarded for non-method blank corrected data. Refer to Section 12.6 (Data Reporting) for specific instructions on how method blanks are evaluated and reported for non-method blank corrected results.

11.1.2.2 Matrix Spikes

Matrix spikes are routinely included in the analytical batch as they are required for most methods utilized at BRL. Method-specific or client-specific frequency and recovery requirements are variable and available in the method, the SOP, or the SOW, whichever is applicable. Matrix spikes are typically analyzed at a frequency of one per every ten client samples. Although not a requirement, if a batch contains samples of different submatrices, matrix spikes should be prepared and analyzed for each submatrix type to ensure that there is no matrix-specific interference. It is up to the client to request additional matrix spikes on their samples if they suspect matrix issues.

The target spiking level of the matrix spikes is 2-5 times the native sample concentration or 5 times the MRL, whichever is greater. However, it is not always possible to know the concentration of the native sample before preparing the matrix spikes. Historical data should always be consulted prior to spiking in-house samples if this data is available. If historical data is available, no further action is required as long as the spiking level is still within 1-20 times the native concentration. If the native result agrees with the historical data and the sample is spiked incorrectly, then the native and its associated matrix spikes should be reprepared and reanalyzed. Lacking historical data for the samples, most methods have default spiking levels. If these levels end up being outside of the acceptable spiking concentration limits (1-20x), then if at all possible a post-digestion spike should be prepared at the target spiking level (2-5 times the native concentration) and analyzed for the sample.

11.1.2.3 Blank Spikes

When spike blanks are employed at the request of a client as an additional QC check to monitor the efficiency of the method, a minimum frequency of one per sample batch must be prepared and analyzed.

The policy at BRL is to analyze one BS at approximately 10 – 20 times the MRL with default acceptance criteria of 75-125% if an appropriate CRM is not available.

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11.1.2.4 Performance Evaluation (PE) Samples

Performance Evaluation samples are analyzed as blind samples and are analyzed at a minimum of semi-annually. BRL purchases PE samples from Environmental Resource Associates (ERA) semi-annually. All PE studies utilize samples that are blind not only to the analyst but also the entire laboratory staff until after the results have been submitted to the appropriate agency and the final report for the study is issued. ERA PE results are forwarded directly to BRL, the Washington State Dept. of Ecology, Sate of Florida Dept. of Health, Oregon State Environmental Laboratory Accreditation Program, State of Louisiana Dept. of Environmental Quality, State of New Jersey Dept. of Environmental Protection, New York State Dept. of Health, California Dept. of Health Services, and the Maine Dept. of Health and Human Services for accreditation purposes.

Additionally, BRL routinely participates in laboratory intercomparison studies offered by such institutes as the International Atomic Energy Agency (IAEA), the United States Geological Survey (USGS), Florida Department of Environmental Protection, etc. Laboratory intercomparison studies such as these allow BRL the opportunity to evaluate our performance on more non-traditional matrices not typically available from PE providers.

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11.1.2.5 Calibration Verification

Independent Calibration Verification (ICV) standards are standards that are from a different source than the working standards. The ICV is analyzed once immediately following the calibration or at the beginning of an analytical batch. Verification standards made directly from the working standards are also used throughout the analysis to check the continuing accuracy of the calibration. They are often referred to as Continuing Calibration Verification (CCV) standards or Ongoing Precision Recovery (OPR) samples. For most methods utilized at BRL, the CCV/OPR samples must be analyzed at the beginning and the end of an analytical batch and at a frequency of at least 10% throughout the analysis. For most analyses, Continuing Check Blanks (CCB) are analyzed after each CCV/OPR sample to ensure that there is no carry-over of analyte to the field sample analysis. Additional requirements may be specified in the specific analytical method, SOP, or contractual requirements.

11.1.2.6 Quality Control Samples

Quality control (QC) samples are additional QC checks for evaluating the accuracy of the analysis. These samples may be prepared by BRL (as with Laboratory Fortified Blanks) or purchased from an outside source (as with CRMs) depending upon their availability. QC samples range from Laboratory Certified Standards (LCS) to matrix specific CRMs. Regardless of their source, QC samples are always prepared from a different source than the working standards. Frequency and recovery criteria for QC samples are method specific. Refer to the specific analytical method, the SOP, or the SOW for specific frequency and recovery requirements.

11.1.2.7 Duplicates (Method Duplicates or Matrix Spike Duplicates)

Duplicate samples or matrix spike duplicates must be analyzed at a minimum frequency of 10% per analytical batch for all analytical methods employed at BRL. If a batch contains samples with different matrices, then duplicates should be analyzed for each matrix. Refer

to the specific analytical method, the SOP, or the SOW for specific frequency and precision requirements.

11.1.2.8 Reagents and Standards Purity Checks

All reagents used in the preservation, preparation or analysis of samples must be checked for the appropriate parameters prior to use. All reagent testing results are stored electronically on the server and the reagents are then labeled with the BRL assigned lot number, the date of testing and the measured concentrations of the analytes of interest.

Likewise, all standards are tested against previously tested, non-expired standards prior to use to ensure that they are acceptable for use as calibration, calibration verification, or spiking standards.

11.2 Routine Methods Used to Assess Precision and Accuracy

11.2.1 Accuracy and Precision

11.2.1.1 Precision

Precision from two or more replicates is expressed as % Relative Percent Difference (% RPD) or % Relative Standard Deviation (or % RED) and shall be calculated from the following formulae:

$$RPD = \left(\frac{|a - b|}{\bar{x}} \right) \times 100$$

Where: a = result a from native sample, or for matrix spike samples, result from the matrix spike (native + spike concentration) sample
b = result b from native sample duplicate, or for matrix spike samples, result from the matrix spike duplicate (native + spike duplicate concentration) sample
$\bar{x}$ = Mean (average) of the two results

$$\%RSD = \left(\frac{s}{\bar{x}} \right) \times 100$$

Where: $\bar{x}$ = Mean (average) of the data points
s = Standard deviation calculated as:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$$

Where: x_i = the individual data point for each n
n = the total number of data points

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11.2.1.2 Accuracy from Spiked Samples

The accuracy of a measurement shall be determined by the recovery of a known amount of analyte in a real sample as:

$$\%R = \left(\frac{Cs - Cu}{S} \right) \times 100$$

Where: Cs = concentration of spiked sample
Cu = concentration in non-spiked sample (can be 0 for results < MDL)
S = expected concentration (spiking level)
%R = percent recovery

11.2.1.3 Accuracy from Known Concentrations

The accuracy of a measurement based on known concentrations shall be calculated as:

$$\%R = \left(\frac{\text{Sample concentration}}{\text{Reported True Value}} \right) \times 100$$

11.2.1.4 Upper and Lower Warning and Control Limits for Acceptance Criteria

Upper and Lower Warning Limits (WL) and Control Limits (CL) for determining acceptance criteria shall be calculated as follows:

$$CL = P_{av} \pm 3s$$

where: CL = Control Limit (upper and/or lower)
P_{av} = Mean of P (percent recovery or RPD)
s = standard deviation of the mean of P

and

$$WL = P_{av} \pm 2s$$

where: WL = Warning Limit (upper and/or lower)

11.2.2 Quality Control Charts

Quality Control charts are used to determine acceptance criteria for in-house developed methods and review the relevance of QA criteria parameters used in each analytical method. Separate quality control charts should be established for each analytical method, for each parameter or analyte, and for each matrix type, both for precision and for accuracy. Control charts are automatically updated for all test codes in the LIMS as data is uploaded.

Control charts are constructed and used to monitor laboratory certified standards and SRMs/CRMs performances, spike recoveries, duplicate analyses, calibration verification standard recoveries, and blank analyses. Control charts use both the mean and standard deviation in order to identify out-of-control events as per Standard Methods, 21st Edition, Section 1020 B.

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The LIMS automatically generates control charts, where the mean and the standard deviation, warning limits, and control limits are automatically calculated and updated. Control charts can be determined by method, who prepared the samples, who analyzed the samples, which instrument was used to analyze the samples, and over what dates the samples were analyzed. The individual data points are plotted against the mean and the ± 2 (warning limit), ± 3 (control limit), and ± 4 standard deviations.

It takes a minimum of 10 data points from at least 3 non-consecutive calendar days of analysis to "define" a control chart. The use of "real time" control charts is instrumental in indicating when an analysis is out-of-control. Out-of-control events may be indicated by the following occurrences.

1) QC sample result that exceeds the control limit even after reanalysis
2) Three out of four consecutive QC sample results that exceed the warning limit
3) Five out of six consecutive QC sample results exceed ± one standard deviation from the mean
4) Five consecutive QC sample results in decreasing or increasing order in the same calibration
5) Seven consecutive QC sample results are on the same side of the mean (Only applies to QC samples used to measure accuracy and not those used to measure precision)

An outlier is an extreme value, high or low, that has questionable validity as a member of the measurement set with which it is associated. Outliers are **not** used in assembling the quality control charts for purposes of setting acceptance limits. Outliers may be rejected from the data set for the following reasons:

- A known experimental aberration occurred, such as instrument failure or inconsistency in the procedure or technique

- The T value for the data is larger than the tabulated values using the Grubb's test for outliers (Table 12.1). Outliers at BRL are determined with a 95% confidence level (or 5% risk of false rejection). The T value is calculated using the following equation:

$$T = \frac{|X_0 - \overline{X}|}{SD}$$

where: X_0 is the extreme value being measured
$\overline{X}$ is the mean of the measurement set for *n* observations including X_0
SD is the standard deviation associated with X including X_0

If a value is rejected, the mean and standard deviation are recalculated using the remaining data. This procedure can be reiterated using the next extreme value until no outliers remain.

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TABLE 11.2 - GRUBB'S TEST FOR OUTLIERS

Number of	Risk of False Rejection				
Data Points	0.1%	0.5%	1%	**5%**	10%
3	1.155	1.155	1.155	**1.153**	1.148
4	1.496	1.496	1.492	**1.463**	1.425
5	1.780	1.764	1.749	**1.672**	1.602
6	2.011	1.973	1.944	**1.822**	1.729
7	2.201	2.139	2.097	**1.938**	1.828
8	2.358	2.274	2.221	**2.032**	1.909
9	2.492	2.387	2.323	**2.110**	1.977
10	2.606	2.482	2.410	**2.176**	2.036
15	2.997	2.806	2.705	**2.409**	2.247
20	3.230	3.001	2.884	**2.557**	2.385
25	3.389	3.135	3.009	**2.663**	2.486
50	3.789	3.483	3.336	**2.956**	2.768
100	4.084	3.754	3.600	**3.207**	3.017

Tabulated values obtained from Quality Assurance of Chemical Measurements by John Keenan Taylor, 1987.

11.3 Method Detection Limits

The method detection limit (MDL) is the minimum concentration of an analyte of interest that can be measured and reported with 95 percent confidence that the value is above zero. MDLs are determined by replicate analysis of a sample that is one to five times the estimated detection limit for the analyte of concern or up to 10 times the level for multi-element tests. The sample aliquots to be used may be from a native sample or a representative matrix that has sufficient analyte (present or spiked) to make the concentration one to five times the estimated MDL. If a sample low enough in the analyte of interest is not available, then method blanks may be spiked at the appropriate level for the MDL study. A minimum of seven sample aliquots (BRL routinely prepares and analyzes eight MDL samples) must be analyzed for the determination of the MDL. As long as seven sample aliquots remain, one MDL sample may be discarded, but only if there is a defensible reason for doing so (e.g. the auto sampler did not sample the cup, sample was not spiked, etc.). The reason for the abnormal result must be known and it must be shown that no other sample results could have been affected. The MDL is then calculated as the standard deviation of the replicate analysis multiplied by the "student's t" value for the number of replicates analyzed (3.143 for seven replicates; 2.998 for eight replicates). When evaluating a MDL, the sample aliquots must be carried through the entire method as per client samples. If, for a particular method of analysis, the concentration in the sample aliquots is below the MDL, then they cannot be used to calculate the MDL. In such a case, the MDL study is repeated with appropriately spiked MDL samples. More specific information on the MDL procedure and calculation are found in the EPA in "Definition and Procedure for the Determination of the Method Detection Limit - Revision 1.11", 40 CFR 136, Appendix B.

MDLs are determined for each method used at BRL prior to the analysis of client samples by that particular method. For research methods or methods that BRL is not accredited for use, MDLs may be estimated from the standard deviation of the method blanks. New MDL studies are performed

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annually for aqueous samples and biennially for solids methods. More frequent MDL studies may be required by accrediting bodies or at the discretion of BRL management. Additionally, the MDL must be re-determined any time major changes in a procedure are made. Major changes include changes in personnel, instrumentation, procedural changes to either the preparation or the analysis of samples, etc. The MDL study is intended to represent the capabilities of BRL and; therefore, should only be performed by experienced analysts.

As part of the MDL study, a Limit of Detection (LOD) validation check must be performed either during or immediately following the study (within one week and prior to analyzing any samples using the new MDL) on all instruments that might be used for the analysis. The LOD validation check consists of an appropriate sample prepared at 2 – 3 times the determined MDL for single analyte tests and 1 – 4 times the MDL for multi-analyte tests. The response produced during the analysis of the LOD validation check sample must be greater than 3 times above the instrument's noise level to be acceptable. If the LOD validation sample analysis fails to meet the acceptance criterion, then additional LOD validation checks must be performed at a higher level to set a higher MDL or the MDL study must be re-conducted. The MDL verification check sample must be analyzed quarterly on each instrument used to analyze samples. As a rule, the MDL verification sample is prepared and analyzed at levels of 1, 2, and 3 times the MDL when first establishing the MDL/LOD and then at 2 to 3 times the MDL quarterly. It is BRL policy to always set the LOD at a level of at least 2 times the MDL and no more than 3 times the MDL.

Brooks Rand Labs currently defines the different units for the MDL validation test as such.

- **Background Noise**: The average response of the instrument or calibration blanks during a single analytical run (sequence).
- **Instrument Noise**: The variation of the individual instrument or calibration blanks around the background noise during the sequence. To be as conservative as possible, this is measured for any single sequence as the absolute difference between the response of the lowest and the highest instrument blanks.
- **MDL Verification Sample Response**: This is measured as the instrument response for the analysis of the MDL verification sample corrected for the background noise.

For example, instrument response for total mercury analysis is measured in units of peak area (PA). If four calibration blanks were analyzed and gave responses of 59 PA, 98 PA, 81 PA, and 69 PA, then the background noise would be the average (76.75 PA or 77 PA) and the instrument noise would be 98 PA – 59 PA = 39 PA. For this example, the instrument response for the MDL validation sample would need to be greater than 77 PA + (3 x 39 PA) or greater than 194 PA in order for the MDL validation criteria to be met.

NOTE: The requirement of the MDL verification check may be met through the analysis of client samples prepared with a batch that happen to be approximately 2 times the determined MDL. That is, a specific MDL verification sample need not be prepared if another sample prepared with the batch meets the requirements of the MDL verification sample. However, the initial MDL verification immediately following a new MDL study must be performed prior to any sample analysis.

Some additional clarification is required between how NELAC and the DoD QSM use the MDL verification sample to establish the Limit of Detection (LOD). NELAC treats the LOD as BRL treats the MDL; namely, the LOD is the detection limit (DL) for the method of interest

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and is verified by analyzing an LOD validation check sample. The DoD QSM defines the DL for the method in the same way that BRL defines the MDL. However, by the DoD QSM, the LOD is set by the level of the LOD validation check sample and it will always be greater than the DL. What this means is that for work covered by the NELAC standard and any work not requiring accreditation, BRL will report down to the MDL unless otherwise specified in the contract. Whereas, for work covered by the DoD QSM, BRL will report down to the level of the lowest LOD validation sample that meets the acceptance criteria, but not below the MDL.

All MDL studies are documented and the Quality Assurance Manager keeps the documentation on file. Documentation includes the date of the study, the name of the analyst conducting the study, the analytical method(s), the analyte of interest, preparation notes, and all raw data from analysis.

The method reporting limit (MRL) is based on the level of the low standard used in the instrument calibration and the volumes/weights used in the analysis of samples. The MRL cannot be less than the MDL and is typically 3 to 10 times the MDL. The Limit of Quantitation (LOQ) is the concentration of an analyte of interest where the relative confidence in the measured value is ± 30% at the 95% confidence level. LOQs are estimated as 9 to 12 times the standard deviation from the MDL determination. Whenever possible, BRL sets the MRL to be equivalent to the LOQ by adjusting the level of the low standard to be equal to the LOQ.

The validity of the LOQ/MRL is confirmed quarterly for each instrument used with the analysis of four laboratory fortified blank samples spiked at 1 – 2 times the level of the LOQ/MRL. Recovery of the LOQ/MRL LFB is judged against the established method acceptance criteria or client data quality objectives, whichever are more stringent, for precision and accuracy.

The instrument detection limit (IDL) is determined at initial set-up of the instrument and after any significant change (such as change in equipment or reagents used, carrier gases, gas pressures, etc.). Additionally, an IDL study may be used as part of an analyst's demonstration of capability as long as their ability to prepare samples is not being evaluated. A minimum of seven analytical spikes prepared at the level of the low calibration standard are analyzed and the IDL is then calculated as the standard deviation of the replicate analysis multiplied by the Student t value ($t_{.99}$) for the number of replicates analyzed (3.143 for seven replicates; 2.998 for eight replicates). The calculated IDL must be less than the MDL for all methods analyzed on the instrument. Additionally, a minimum of four analytical spikes prepared at approximately 10 times the MRL are analyzed. The recovery and standard deviation of these QCS samples must meet sample specific requirements of the method being performed.

11.4 Initial and Continuing Demonstration of Capability

11.4.1 Initial Demonstration of Capability (IDOC)

Every analyst must perform an IDOC study prior to analyzing samples. An MDL study is typically part of an analyst's IDOC, but is not required since it will also be affected by the preparation of the samples and isn't fully indicative of the analyst's ability to properly analyze sample preparations. If an MDL is not part of the IDOC, then an IDL study is performed where a minimum of seven analytical spikes prepared at the level of the low calibration standard by the analyst at the instrument must be analyzed. These samples are analyzed as per an MDL

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study and the resulting detection limit must be less than the MDL for the analytical method. In addition, a minimum of four QCS samples are prepared as per the specific analytical method requirements (typically at a concentration that is 10 times the level of the MRL) and analyzed. The average recovery and the RSD yielded by the analysis of the QCS samples must meet the specific requirements of the analytical method being performed. A new IDOC must be performed anytime there is a change in instrument type, personnel, or test method (including changes to either the preparation or analysis of samples). Specific requirements for a passing IDOC are outlined in BRL SOP BR-1206 (MDL Studies, Validation, and Demonstration of Capability).

11.4.2 Continuing Demonstration of Capability (CDOC)

In addition to performing an IDOC prior to beginning analysis, each analyst must demonstrate that he is continuously capable of performing the analysis. This capability is judged annually by reviewing control charts for the methods performed by the analyst, looking at four consecutive batches performed by the analyst to ensure that all batch specific QA was met, or by having the analyst perform another IDOC study while analyzing the annual MDL study to demonstrate that the analyst is still capable of obtaining accurate and precise results. The full analyte list need not be reviewed for multi-analyte analyses to show continuing capability. At a minimum, 6 analytes will be reviewed, including typically problematic analytes such as selenium, silver, and zinc. Specific requirements for a passing CDOC are outlined in BRL SOP BR-1206 (MDL Studies, Validation, and Demonstration of Capability). If the analyst has not demonstrated continuing capability for a method, then the Laboratory Manager will determine if additional training is required and the analyst must successfully perform an IDOC prior to analyzing any further client samples.

11.4.3 Documentation

All raw data, including preparation logs, analytical bench sheets, and instrument printouts, used to perform the IDOC or CDOC study are scanned and attached to the relevant sequence in the LIMS. Additionally, hard copies of the preparation logs and analytical benchsheets are filed by the QA Department and maintained for no less than seven years from when the analyst stops working at BRL. All IDOC and CDOC studies must be reviewed by the QA Department and the QA Manager must annually certify that each analyst is capable of performing their respective duties by completing a Demonstration of Capability Certification Statement form for each method an analyst performs. These forms are kept in the employee training records. A copy of this form is presented on the following page.

11.5 General QC Requirement Statement

The QC requirements previously listed are general requirements only. Specific methods or client-specific Statements of Work may have more stringent requirements that take precedence.

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Demonstration of Capability
Certification Statement

Date: Page __ of __

Laboratory Name: **Brooks Rand Labs**
Laboratory Address: **3958 6th Avenue NW**
Seattle, WA 98107

Analyst(s) Name(s):

Prep Tech Name (if applicable):

Matrix:

Method number, SOP#, Rev#, and Analyte or Class of Analytes or Measured Parameters:

Criterion Used (MDL Study, Consecutive Analysis, etc):

The undersigned CERTIFY that:

1) The analyst (and prep technician if applicable) identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, has met the requirements for the Demonstration of Capability.
2) The test method(s) was performed by the analyst(s)/prep tech(s) identified above.
3) A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.
4) The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory (1).
5) All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.

Technical Director	Signature	Date
Quality Assurance Manager's Name	Signature	Date

This certification form must be completed annually or each time a demonstration of capability study is completed.

(1) True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-Explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

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12.0 Data Reduction, Validation, Reporting and Storage

Prior to release of analytical results, all unknown sample and associated quality control data are subjected to the full review process briefly described below. Refer to BRL SOPs BR-1300, BR-1301, and BR-1302 for a detailed description of the data review procedure.

12.1 Analytical Integration

Analytical instrumentation signal output is integrated by BRL-developed integration software (i.e., Guru™) or by manufacturer specific software (i.e., Perkin Elmer Elan and Chromera software). Analytical runs are stored electronically. Integration software is verified by the QA samples. Any integration software related problem that affects samples would also affect QA samples; therefore, as long as QA criteria are met, the software is assumed to be operating properly. The electronics department at BRL maintains all documentation of integration software upgrades.

12.2 Data Reduction

The analyst is responsible for uploading all data into the LIMS and performing primary validation of the data. Initial data reduction is performed by the instrument software to obtain initial results in units of measured pg, measured ng, or µg/L. This information, along with volumes/masses used in the preparation/analysis of the samples is either uploaded or hand entered into the LIMS where final results are calculated according to the method used to analyze the samples. The following documentation must be present with every data package: preparation notes, SPFs, lab bench sheets, Analysis Sequence printout, and analyst's notes. All instrument printouts are stored electronically as PDF files and must have the analytical batch recorded on them and the sample ID for each instrument response.

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12.3 Data Entry

The preparation technician or analyst is responsible for entering all sample masses/volumes and preparation volumes into the bench sheet in the LIMS, as well as any batch specific QC information. The analyst is responsible for checking this information, entering all analytical specific information into the instrument software, and uploading all of the instrument results into the LIMS. The analyst first ensures that all data is present and that all previous sections on the SPF have been completed and signed-off. All final results are automatically calculated in the LIMS using formulas specific to the analytical method used.

12.4 Primary Data Review

After the data has been acquired and any necessary calculations performed, the primary data review is performed by the analyst. Items to be reviewed include correct upload of the data, sample identity, instrument calibration, QC samples, detection limits, numerical computations, accuracy of transcriptions, sample preparation logs, instrument/analytical logs, and compliance with the individual method. Software used for data entry is verified to be working properly by the data entry verification protocols described in BRL SOPs BR-1300 and BR-1301. Any software problems or

failures are documented as correspondence between the IT Manager and the software manufacturer. The IT Manager keeps all such documentation/correspondence on file.

12.5 Final Data Review and Validation

Following the analyst's review, the raw data and calculations undergo final review by the QA Group. The QA Group also reviews comments about analytical conditions as well as any interpretations made by the analyst. Additionally, the QA Group examines the QC sample data and ensures that the analytical results meet or exceed the acceptance criteria for frequency, accuracy, and precision.

Data validation is part of the review process whereby data are inspected and either accepted, rejected, or qualified based on a set of criteria. Evaluation parameters that can be used for validation include, but are not limited to:

- Calibration data
- Specific checks unique to each measurement
- Statistical tests

After final data review and validation is complete, the QA Group applies any necessary data qualifiers, sets data to be reported to "reportable," and signs-off on the sample processing form. Only the QA Manager or delegate and, in extreme cases, the Lab Manager or VP of Analytical Services have authority to change the reportability of data after final data review. All changes in the status of data (e.g. batched, prepared, analyzed, reviewed – primary, reviewed – final, reportable versus non-reportable, etc.) is updated automatically in the LIMS with a time stamp and identity of the person that made the change.

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12.6 Data Reporting

Prior to data reporting, the Project Manager responsible for the report reviews that data a final time for any discrepancies. The final client report is generated only when the Project Manager is satisfied that the data is valid and all project specific requirements have been met. Any Level IV report or reports where issues require additional narration goes through secondary review by another Project Manager or Project Coordinator who then signs-off on the report as well. Only then is the report sent to the client.

Typically at BRL, results are reported down to the MDL. Results $\leq$ the MDL are reported at the MDL and qualified "U" as non-detectable. Results at or below the MRL but above the MDL are reported as the calculated result and qualified "B" as an estimate. Results above the MRL are reported as the calculated result without qualification. For Department of Defense (DoD) work, results are either reported only down to the LOQ or by the rules defined in Gray Box 47 of the DoD QSM 4.2. All sample results are reported to three significant figures except for percent total solids results and results for QC samples, which are both reported to four significant figures. Sediment and soil results are typically reported on a dry-weight basis by dividing the wet weight result by the percent total solids result. Biota results are typically reported on a wet-weight basis. However, upon request, biota results may be reported on a dry-weight basis as well.

Any sample that yields a non-detectable result and shows <30% recovery of the matrix spike cannot be reported. The sample is qualified "R" to indicate that all generated results for the sample are unusable and no result for the sample is reported. Refer to section 11.3 for differences in how the limits of detection are defined between work performed under the NELAC standard and work performed under the DoD QSM and how this affects how results are reported by BRL.

It is BRL policy to always method blank correct results (with the exception of total solids and total suspended solids). In extreme cases where the client requires results that have not been method blank corrected, the criterion for acceptable method blanks is that the absolute value of the highest method blank concentration for any detectable (> MDL) method blank must be ≤ 10% of any detectable (> MDL) result. Any detectable result not ≥ 10 times the absolute value of the highest detectable method blank concentration is qualified "X" and narrated as being an estimate due to elevated method blanks with either high or low bias depending on whether the method blank concentration is a positive or negative value.

Another extreme case where it may not be appropriate to blank correct data is when there are highly variable blanks that do not meet the method blank criteria. In such cases, it is better to report results without blank correction as previously described. When reporting results without method blank correction, the reporting limits should not be adjusted. Instead, any results affected due to random or elevated method blanks are appropriately qualified using the "X" qualifier. Refer to Section 11.1.2.1 for further discussion on method blanks.

Data that is not method blank corrected is reviewed and qualified using the same acceptance criteria as blank corrected data with one caveat. Samples are not reprepared or reanalyzed if failing non-blank corrected QC would have passed if it had been blank corrected as per standard practice. In such cases, the data is qualified accordingly and reported unless specified otherwise in the client contract.

Generally, data are reported in a format generated by the BRL LIMS with a case narrative or a cover letter attached. All of the data, including standard spike recoveries, control samples, duplicate analyses, and results from blank analyses, are reported along with the sample results. Data quality issues are addressed in the cover letter or case narrative, which discuss each batch analyzed in the sequence. Final reports are submitted to all required parties (project dependent). A copy of each report stored electronically as a PDF file for BRL's internal records (see 12.7 data storage). All laboratory report forms and reporting formats shall be in compliance with the reporting requirements of the applicable project for which they are generated. A specific statement clearly identifying any results that do not meet the specific project requirements (i.e. non-NELAP accredited or non-DoD accredited work performed by BRL) is included, if applicable, in the final report.

Every reasonable effort is made to report data with acceptable associated quality assurance sample (QC) results. However, barring this, data is qualified appropriately to indicate when batch QC does not meet specific acceptance criteria. A list of all data qualifiers and their definitions is included with every data report. While Brooks Rand Labs has its own in-house data qualifiers that are defined on the "Report Information" page of the report, the use of project or accreditation specific qualifiers always take precedence over BRL qualifiers. In such instances, the project specific

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qualifier definitions would over-ride the BRL qualifier definitions on the "Reporting Information" page of the final report and discrepancies would be narrated.

Electronic files may be transferred to a client via electronic data deliverable (EDD) or by email with the following statement:

> CONFIDENTIAL
> This electronic message transmission (including any attachments) is intended only for use by the addressee(s) named herein; it contains legally privileged and confidential information. If you are not the intended recipient, you are hereby notified that any dissemination, distribution, printing, or copying is strictly prohibited. If you have received this e-mail in error, please notify the sender and permanently delete any copies thereof.

Disclosing information about client results or contracts to any party outside of Brooks Rand Labs without prior permission from the client and Brooks Rand Labs and without following all reporting policies stated in the Brooks Rand Labs Comprehensive Quality Assurance Plan and associated standard operating procedures is forbidden by all personnel. The term "reporting" refers to any electronic, written, or spoken discussion of client data or other confidential and proprietary information. To protect the client's proprietary rights, data must never be reported over the phone. Additionally, data can only be reported directly to the client with whom Brooks Rand Labs has a legal contract to perform work, unless BRL has written permission from the client to release the data or report to a third party.

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12.7 Data Storage

For all data generated by Brooks Rand Labs prior to October 15, 2006, hard copies of all data and documentation will be kept on file for a minimum of five years unless contract specific requirements call for longer storage. Data and documentation to be stored include: SPFs, preparation notes, lab bench sheets, lab notebooks used in reduction, instrument printouts, and any results spreadsheets (i.e., Excel® spreadsheets used to calculate values). The QA Manager is responsible for maintaining files of all batch specific hard data. The last 6 months worth of batch specific hard data is stored in cabinets located in the main office area. The previous year's batch specific hard data is stored in the overhead space of the conference room. Any earlier batch specific hard data is stored in a secure facility off BRL premises. The Project Manager is responsible for maintaining all client specific files. Most client files are saved electronically and not in hardcopy. All MDL study documentation and other QA documentation are scanned and attached to the relevant sequence in the LIMS. Hard copies of the original data are filed by the QA Department by date. All data generated following October 15, 2006 are scanned and stored electronically for a minimum of ten years. After five years, electronic data may be removed from the server, but is backed up to two separate external hard drives that are stored at separate, secure locations. Any paper work that has not been scanned for any reason will be stored for a minimum of five years.

Note: The following procedure is done for clients with data prior to October 15, 2006 that require data to be maintained for more than 5 years to ensure that data is not inadvertently lost. Hardcopy data prior to October 15, 2006 is pulled from storage and then scanned to the server and stored as electronic data for as long as required by the project.

Electronic summaries of data will be kept for a minimum of 10 years. All computer files are stored both on computer hard drive and on backup disks. Computer files of client reports are organized by sample tracking number, batch spreadsheets are organized by batch number, and all project information is organized by project numbers. All client reports are scanned and stored electronically. These reports contain copies of the original SRL, as well as any information provided by the client including chain-of-custody forms, analysis request forms, airbills (full reports only), etc. Since October 15, 2006, all sequence specific data has also been scanned and stored electronically. The original hardcopy batch data is stored for at least 6 months in the file cabinets in the main office before being shredded. All hard copy data previous to October 15, 2006 will be stored for a minimum of five years from the date of reporting before being shredded. All employees at BRL are authorized to access electronic information. No levels of accessibility for employees exist. The IT Manager monitors the upkeep of computer files.

All hard copies of any documents that could be traced directly to a client are destroyed by shredding prior to disposal.

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13.0 Document Control Policies

13.1 SOPs, Manuals, Handbooks, and Plans

All documents important to the internal operations of BRL go through formal procedures as to their writing, approval, implementation, retirement, and sharing.

13.1.1 Writing and Approval of SOPs, Manuals, Handbooks, and Plans

Once it has been determined that a new policy or procedure is required at BRL, the most appropriate employee(s) (i.e., whoever has the most knowledge or experience in the given area) is/are delegated to write a document detailing the policy or procedure. Once the document has been written, it must pass up through a chain of approval specific to the type of document being written.

All SOPs begin with the appropriate person writing the procedure. The Group Leader (if applicable), the QA Manager, and, finally, the Lab Manager then must approve the SOP (in that order). The CQAP must be approved in order by the QA Manager and the VP of Analytical Services. BRL Handbooks and Plans follow their own specific chain-of-approval processes, with final approval coming from the VP of Analytical Services or President.

If an error is discovered during any portion of the approval process, the person who found the error makes a note of it and sends the document back to the original writer. It is the writer's responsibility to address the error and then reinitiate the approval process from the very beginning.

Upon approval, each person in the chain of approval must sign and date the document. Only upon final approval is the document considered to be in force and all procedures within the document from that date forth are enforced until the document is retired (see section 13.1.3).

13.1.2 Annual Review of SOPs, Manuals, Handbooks, and Plans

All BRL documents are reviewed annually. If no changes in the procedure are required, the reviewer signs and dates the document as being reviewed. If changes are required, the appropriate employee is designated to make the required revisions. The new revision of the document must then go through the same chain of approval it went through for its initial writing. Upon final approval, the new revision is considered in force, and the old revision is retired. Refer to SOP BR-1400 for specific procedures to follow when revising an SOP.

13.1.3 Retirement of SOPs, Manuals, Handbooks, and Plans

When a BRL document is retired, the original is clearly labeled "outdated" and the date of its retirement is also clearly indicated. All copies of the retired document are either destroyed or also clearly labeled as being outdated. The original is then archived as a historical record (either electronically as a PDF file or as a hardcopy) for no less than five years.

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13.1.4 Proprietary Information

Many of the analytical methods used at BRL have been developed in-house and are considered proprietary information. Clients or other organizations requesting particular SOPs are required to first sign an "Agreement for Confidential Disclosure and Restricted Use of Proprietary Information." Whenever possible, "client ready" SOPs, where all proprietary information has been removed, are given to clients instead of full SOPs.

13.1.5 Uncontrolled Documents

Uncontrolled documents are defined as any document (CQAP, SOP, "cheat sheet", etc.) or portion thereof that has not been signed and dated as being approved for use in the laboratory and is not under the direct control of the QA Manager. No such document is allowed to posted or used in the laboratory and must be immediately removed upon detection. When referencing the CQAP or an SOP, the current approved version should be opened directly from the server from the following folder: Y:\SOP & other DOCs. All documents in this folder are PDF versions with signed and dated cover pages. If "cheat sheets" or isolated pages from SOPs would be of value in the lab, then these must be approved by the QA Manager who then signs and dates the pages and combines them into a controlled logbook for the laboratory.

13.1.6 Master List of Controlled Documents

The Quality Assurance Manager is responsible for maintaining a master list for the location of all controlled documents. The list must contain the following information:

- Title of controlled document
- Revision number
- Location stored or name person in possession of
- Date printed or sent electronically

13.2 Client Records

All client reports, records of results, and correspondences are maintained by BRL for a period of no less than five years. All project information is electronically stored on the server for a minimum of 10 years. All "Active Client" specific files are maintained by the Project Manager. All client data generated following October 15, 2006 is scanned and stored electronically for a minimum of ten years.

In the event that BRL should go out of business, it is BRL's stated policy that every attempt will be made to notify all clients (past and present) and ask them how they would wish to have their records maintained or transferred. In the advent of a change in ownership, it is BRL's policy that all records become the property of the new owner unless specifically requested otherwise by the client. All reasonable demands of the client shall be met and no client information shall be removed from BRL premises without the client's written consent.

13.3 Employee Records

All employee records, including resumes, training, IDOC and MDL studies, are maintained by BRL for a period of no less than seven years following the departure of the employee.

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14.0 Information Systems

14.1 Hardware

A local area network (LAN) connects staff computers and printers for local access, as well as providing external email, faxes, and Internet access. The server computer is a Dell PowerEdge 1900 running Microsoft® Small Business Server 2003 R2. The server is configured as a primary domain controller and print server for networked printers. It is equipped with three 146 gigabyte hard disk drives and employs RAID 5. The redundant array will prevent data loss in the event of a single hard drive failure.

A dedicated server runs the LIMS application and is accessible via the LAN. The hardware is a Hewlett-Packard ProLiant DL180 G5 Server. It has six 250 GB hard disk drives. The data resides on a three disk RAID 5 array. The OS resides on a two disk RAID 1 array. The sixth HDD is a spare hot swappable disk. The OS is Microsoft® Windows Server 2008. The LIMS program runs on SQL Server 2005 application.

A terminal server is configured to provide remote access for offsite employees. The server is a Dell PowerEdge 700 running Microsoft® Small Business Server 2003 R2 and Terminal Services.

14.2 System Backup

Backup software, Retrospect version 7.0, provides scheduling, automation and monitoring of backup for both server and workstation files. The software is run on a networked spare workstation. All data files located on the server are backed up daily. These include the LIMS file (Microsoft® SQL Server), instrument data, and client-related files. Other selected files on the workstation are also backed up weekly.

Three external hard drives are used to perform the backups. The hard drive connected to the backup workstation remains so for three weeks, after which it is removed to an offsite location and the external hard drive with the oldest backed up data is then connected to the backup PC.

14.3 Security

A Netscreen-5GT router/firewall protects the LAN from the public internet. Workstation access is available to all authorized employees via domain logon. Shared data is available throughout the local network. Specific directories or files may be protected from access using Group Policy security settings if the data owner considers it necessary. Data loss is safeguarded through redundancy. Redundancy is accomplished via backups as mentioned and secure storage of data in hard copy.

All computer accounts are password protected so that unauthorized access is not allowed. Individuals are required to logoff of computers when they leave the workstation.

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15.0 Corrective Action

15.1 Corrective Action

The laboratory has a corrective action system to identify any situations that may adversely affect data quality. These situations include, but are not limited to:

- Results outside of quality control criteria as outlined in individual SOPs
- Statistically out-of-control-events
- Deviations from normally expected results
- Suspect data
- Deviations from the method
- Special sample handling requirements

Corrective action may also be initiated as a result of other QA activities, such as performance or system audits.

Once a requirement for corrective action has been identified, the Lab Manager and/or the QA Manager must be notified immediately. A verbal notification may be initially made; however, written documentation of the problem is required typically using an incident report form (Refer to Brooks Rand Labs SOP BR-1204). The QA Manager is responsible for evaluating the situation and determining the appropriate corrective action. The QA Manager has stop work and resume work authority whenever a nonconformance issue may threaten the quality of data produced by Brooks Rand Labs. Corrective action steps include, but are not limited to:

- Problem identification
- Investigation to determine the cause of the condition
- Action to eliminate the problem
- Increased monitoring to evaluate the effectiveness of the corrective action
- Verification that the problem has been eliminated

Documentation of problems requiring corrective action is important to overall laboratory management. Any lab personnel may initiate a corrective action, but it is the QA Manager who is responsible for ensuring that the action is documented. The QA Manager is also responsible for verifying that initial action has taken place and appears effective and, after an appropriate time, for checking to see if the problem has been fully resolved. Examples of corrective action include, but are not limited to:

- Amending forms
- Reanalyzing samples if holding times permit
- Checking instrumentation to make sure that it is operating properly
- Recalibrating with fresh standards
- Replacing suspect reagents
- Examining calculations
- Additional training in sample preparation and analysis

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- Evaluating and amending procedures
- Accepting the data and acknowledging the level of uncertainty or inaccuracy by flagging the data and providing an explanation for the qualification

15.2 Client Communication and Complaints

Brooks Rand Labs is committed to providing the best laboratory services available in the industry. To this end it is vital that good and proper communication is always maintained with our clients. Clients' opinions of the services provided by Brooks Rand Labs are very important to us. All client comments, whether positive or negative, are taken seriously. If a client has a complaint, it is recorded and kept on file by the Client Services Manager. Complaints may encompass any aspect of the services provided by BRL, including analytical services, technical services, or quality assurance.

Once a complaint has been recorded, the BRL manager who is most responsible for the service to which the complaint is directed shall handle the matter with the client. If necessary, the BRL manager will initiate a corrective action to deal with any legitimate deficiencies brought to our attention by clients. The resolution of all complaints shall be recorded along with the initial complaint.

Any events that cast doubt on the validity of any test results already reported must be conveyed to the affected client within one business day of when the events become evident to BRL management. In addition to any phone messages, the client must also be promptly notified in writing. This is typically done in the form of an email. If more formal documentation is required, then a signed letter may be provided, as well as copies of any associated corrective actions.

Both negative and positive feedback from clients are reviewed at the end of the year as part of the Managerial Review in an effort to constantly improve the quality system and products and services provided by Brooks Rand Labs.

15.3 External Audits

Corrective action may also be initiated by external audits by regulatory agencies or clients. Brooks Rand Labs considers audits as an opportunity to improve upon our services. Any deficiencies discovered during external audits are documented and corrective actions are initiated to address them.

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16.0 Performance and System Audits

16.1 System Audits

16.1.1 Internal Systems Audits

BRL conducts specific function audits on an annual basis, with a different segment of the laboratory being thoroughly audited each quarter of the year. This audit process is used to ensure that:

- Approved procedures are in place and used
- Sample custody is properly maintained and documented
- Analytical methods are performed properly and documented
- Specific equipment is available, calibrated and in proper working order
- Analysts are properly trained and the training is documented
- Record keeping procedures are being followed and appropriate documentation is maintained

Additionally, laboratory walk-through audits are performed monthly throughout the laboratory. The laboratory is divided into four groups (Sample Control Group, Mercury Group, Trace Metals Group, and Sample Preparation Group). Each group is audited separately. Laboratory walk-through audits are not as thorough the quarterly audits, but serve to ensure that quality assurance procedures are being performed routinely before issues arise. The findings from monthly walk-through audits and any necessary corrective actions are presented in monthly QA reports.

An annual Managerial Review of the quality system is prepared, typically during the month of January. This report consists of a review of the monthly and quarterly audits over the past year, including the documentation, findings, reporting, corrective action, and follow-up. If any findings are still considered open from the past year, then the report should include a list of outstanding findings, a detailed explanation as to how those findings are being addressed, and a form on which to indicate when the findings have been resolved. This review also looks ahead to anticipated issues for the coming year(s). The ultimate purpose of this review is to ensure the continued effectiveness and improvement of the quality systems in place at Brooks Rand Labs.

Various intercalibration exercises with other laboratories also serve as a performance audit of the laboratory analyses.

16.1.2 External Systems Audits

BRL has occasional audits from various clients and accrediting agencies. The principal organizations that conduct audits of BRL's facilities and operations are the Washington State Department of Ecology, the Florida State Department of Environmental Protection as part of the NELAP accreditation, and ACLASS as part of Department of Defense accreditation. BRL views external audits as an excellent tool for evaluating our quality and for finding areas for improvement. BRL always welcomes any client (current or potential) or government agency to conduct on-site audits.

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16.2 Performance Audits

Internal Performance Audits must be conducted at least biannually and may consist of blind samples, split samples with another laboratory (interlaboratory comparison study), QC samples (unknown to the analyst), performance evaluation samples, and/or blind spiked samples. BRL frequently participates in assisting agencies to certify reference materials for use as blind interlaboratory samples. Any of the Analytical Technicians may analyze these performance audit samples. The Project Manager and Lab Manager are responsible for overseeing BRL's participation in each study, and all associated documentation, reporting, and record keeping.

External Performance Evaluations are as follows:

Agency	Study Title	Frequency
ERA	Blind PE samples*	Semi-Annually**
RTC	Blind PE samples*	Semi-Annually**

* As a better indication of overall laboratory performance, PE samples are treated like all other received samples in terms of receipt, preparation, quality control, and analysis.

** Participation in additional PE studies may be required as part of corrective action.

16.3 Annual Management Review of the Quality Systems

Brooks Rand Labs management conducts an annual review of the quality systems to ensure that they are still effective. This review typically takes place during the month of January. All reports by managerial personnel, the outcome from all recent internal and external audits, the results from PE studies and interlaboratory comparisons, changes in the volume and type of work performed, feedback from clients, and corrective actions are taken into account during the managerial review.

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APPENDIX A – Common Abbreviations

AA	–	Atomic Absorption
ASD	–	Analytical Services Department
BLK	–	Method Blank
BRL	–	Brooks Rand Labs
BS	–	Blank Spike
CCV	–	Continuing Calibration Verification
CDOC	–	Continuing Demonstration of Capability
COC	–	Chain of Custody
CQAP	–	Comprehensive Quality Assurance Plan
CRM	–	Certified Reference Material
CVAFS	–	Cold Vapor Atomic Fluorescence Spectrophotometry
DoD QSM	–	Department of Defense Quality Systems Manual
DUP	–	Method Duplicate
EDD	–	Electronic Data Deliverables
EPA	–	Environmental Protection Agency
ERA	–	Environmental resource Associates
FEP	–	Fluorinated Ethylene Propylene (Teflon™)
FLPE	–	Fluorinated High-Density Polyethylene
HDPE	–	High-Density Polyethylene
HEPA	–	High Efficiency Particulate Air
HGAAS	–	Hydride Generation Atomic Absorption Spectrometry
IDOC	–	Initial Demonstration of Capability
ICP-MS	–	Inductively Coupled Plasma – Mass Spectrometry
ICV	–	Initial Calibration Verification
IMD	–	Instrument manufacturing Department
IT	–	Information Technology
LIMS	–	Laboratory Information Management System
LOD	–	Limit of Detection
LOQ	–	Limit of Quantification
MB	–	Method Blank

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MD	–	Method Duplicate
MDL	–	Method Detection Limit
MRL	–	Method Reporting Limit
MS/MSD	–	Matrix Spike / Matrix Spike Duplicate
NELAC	–	National Environmental Laboratory Accreditation Conference
NELAP	–	National Environmental Laboratory Accreditation Program
PQL	–	Practical Quantitation Limit
PM	–	Project Manager
QA	–	Quality Assurance
QC	–	Quality Control
RPD	–	Relative Percent Difference
RSD	–	Relative Standard Deviation
SPF	–	Sample Processing Form
SOP	–	Standard Operating Procedure
SOW	–	Statement of Work
SRM	–	Standard Reference Material
VP	–	Vice President

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APPENDIX B - Standard Operating Procedures

Brooks Rand Labs - Standard Operating Procedures

SOP #	Title
	Analysis (BR-0001 through BR-0099)
BR-0002	BRL Procedure for EPA Method 1631, Appendix to (1/01): Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS)
BR-0003	Determination of Total and "Acid-Labile" Mercury in Aqueous Samples by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS)
BR-0005	Total Volatile Mercury in Water by Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry
BR-0006	Procedure for EPA Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry
BR-0007	BRL Procedure for Determination of Vapor Phase Total Mercury from Stationary Sources Using Dry Sorbent Trap Sampling and Analysis by Cold Vapor Atomic Fluorescence Spectrometry (CVAFS) – Modification of EPA Method 324
BR-0011	Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Waters) and EPA Method 1630, Modified (Solids)
BR-0013	Five-Step Selective Sequential Extraction Procedure (SEP) to Quantify Mercury Fractions in Sediments, Soils and Mine Tailings
BR-0015	BRL Procedure for Reactive Mercury in Tissue, Sludge, Sediment and Soil by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS) Modified from EPA 1631
BR-0020	Determination of Selenium (Se) and Arsenic (As) in Environmental Samples by Hydride Generation-Atomic Absorption with Cryogenic Trap Preconcentration
BR-0021	BRL Procedure for the Analysis of Water, Sediment, and Tissue by EPA Method 1632, Revision A (1/01): Chemical Speciation of Arsenic in Water and Tissue by Hydride Generation Quartz Furnace Atomic Absorption Spectrometry

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Brooks Rand Labs - Standard Operating Procedures

SOP #	Title
	Analysis (BR-0001 through BR-0099 continued)
BR-0060	Determination of Trace Elements by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) using a Perkin-Elmer ELAN DRC II
BR-0061	Trace Element Speciation by High Performance Liquid Chromatography – Inductively Coupled Plasma – Dynamic Reaction Cell – Mass Spectrometry using a Perkin-Elmer ELAN DRC II
BR-0062	Determination of Ag, Al, As, Cd, Cu, Cr, Ni, Sb, Se, V and Zn in Flue Gas Desulphurization Waste Waters by Inductively Coupled Plasma – Dynamic Reaction Cell – Mass Spectrometry using a Perkin Elmer ELAN DRC II
BR-0063	Determination of Trace Elements in Seawaters and Low Level Waters by Online Column Chelation Preconcentration – Inductively Coupled Plasma – Mass Spectrometry using a Perkin-Elmer ELAN DRC II
BR-0065	Aqueous Sample Digestion by Closed-Vessel Oven Heating for Total and Total Recoverable Metals
BR-0066	Reductive Precipitation of Total Recoverable and Dissolved Metals from Brackish and Seawater Samples
BR-0067	Reverse Aqua Regia Oven Bomb Digestion for Total Recoverable Metals in Sediments and Soils
BR-0068	"Total" Metals Digestion in Sediments, Soils, Coal, and Fly Ash
BR-0069	Extraction Using Co-APDC for Nickel, Copper, Silver, Cadmium, and Lead in Water
BR-0070	Total Metals Digestion for Biota Matrices
BR-0080	Determination of Iron Speciation in Water Samples by Colorimetric Detection
BR-0085	Determination of Hexavalent Chromium (Cr^{6+}) in Sediment and Aqueous Samples
	Sample Preparation (BR-0100's)
BR-0104	Metals "Free" Filtration
BR-0106	Sample Homogenization
BR-0107	Filtration for Collection of Particulate from Water Samples

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Brooks Rand Labs - Standard Operating Procedures

SOP #	Title
	Sample Receipt and Storage (BR-0300's)
BR-0300	Receipt of Samples
BR-0301	Sample Custody Maintenance and Tracking
BR-0302	Sample and Client Identification
BR-0303	Sample Storage and Disposal
BR-0304	Sample Processing
BR-0306	Purchase, Receipt, and Storage of Consumable Materials Used for the Technical Operations of the Laboratory
	Decontamination (BR-0400's)
BR-0400	Decontamination of Sample Preparation Equipment
BR-0401	Decontamination of Silicon and Teflon® Tubing and Filter Units for Sample Collection
BR-0402	Metals Decontamination of Glassware
BR-0404	Preventing Trace Metals Contamination of Samples
	Reagents and Standards (BR-0500's)
BR-0500	Documentation of Reagents and Standards
	Security (BR-1000's)
BR-1000	Security of Laboratory and Samples
	Training (BR-1100's)
BR-1100	Training of Laboratory Personnel
BR-1101	Prevention and Detection of Improper, Unethical, and Illegal Actions – Brooks Rand Labs's Data Integrity Plan

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SOP #	Title
	Quality Control (BR-1200's)
BR-1200	Maintaining Instrument and Equipment Records and Logbooks
BR-1201	Internal Laboratory Audits
BR-1202	Evaluating Precision and Accuracy and Estimating Uncertainty in Results
BR-1203	Identifying Systematic Errors
BR-1204	Incident Report and Resolution
BR-1205	Preventative Maintenance
BR-1206	MDL Studies, Validation, and Demonstration of Capability
	Data Validation and Reporting (BR-1300's)
BR-1300	Primary Data Review
BR-1301	Final Data Review
BR-1302	Data Flow and Handling
BR-1303	Reporting
	Documents (BR-1400's)
BR-1400	Writing, Reviewing and Revising Standard Operating Procedures (SOPs)
BR-1401	Records of Client Sample Results
BR-1402	Records of QC Results
BR-1403	Document Control for Standard Operating Procedures (SOPs) and Comprehensive Quality Assurance Plan (CQAP)
	General Determinations (BR-1500's)
BR-1500	Total Suspended Solids in Water
BR-1501	Dry Weight Determination
BR-1502	Determination of Hardness in Water by Calculation
BR-1503	Brooks Rand Labs Procedure for SM 2540G: Total, Fixed and Volatile Solids in Solid and Semisolid Samples – Total Volatile Solids (TVS) Ignited at 550 °C
BR-1504	Measurement of the pH of Solid and Aqueous Samples by Suspension, Centrifugal Separation, and Quantification Using an Electrode-Based pH Meter

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SOP #BR-0011

Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Aqueous Samples) and EPA Method 1630, Modified (Solid Samples)

Brooks Rand Labs

Revision 013e
Written 01/1990
Revised 2/11/2013

Reviewed _____
_____
_____
_____

Lab Manager	2-12-13 Date
QA Manager	2/11/13 Date
Scientist (if applicable)	2/11/13 Date

All Brooks Rand Labs (BRL) SOPs are Proprietary Information and protected by WA state law. Proprietary Information shall be kept in the strictest confidence & shall not be used or appropriated to benefit any party without prior written consent from BRL.

Determination of Monomethylmercury by Aqueous Phase Ethylation, Pre-Concentration, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Waters) and EPA Method 1630, Modified (Solids)

1.0 Scope and Applications

1.1 Method BR-0011 is the performance based procedure followed at Brooks Rand Labs (BRL) as EPA Draft Method 1630. Unless specifically stated otherwise in this document, all apparatus, materials, reagents, standards and procedures as stated in EPA Method 1630 are used at BRL.

1.2 EPA Draft Method 1630 is for the determination of methyl mercury only in filtered and unfiltered aqueous samples. BRL Method BR-0011 is additionally used for the determination of methyl mercury in sediment, biota, and biomonitoring samples. BRL has developed specific sample preparation methods for these matrices. With the exception of the maximum volumes analyzed, the procedures followed for the analysis of sediment and biota preparations are identical to the procedures followed for aqueous preparations.

1.3 EPA Draft Method 1630 describes manual analysis of samples for monomethylmercury (MeHg) determination. Since its publication, Brooks Rand Labs has developed MERX, an automated system for the determination of MeHg. The analytical method in this SOP will refer to use of MERX unless otherwise stated. The manual methodology is retained as an addendum.

2.0 Summary of Method

2.1 Prior to instrumental analysis, all samples are prepared in a way to reduce matrix interference and preserve the MeHg that is present.

2.1.1 Aqueous samples are prepared by distillation at [redacted] according to the procedure discussed in EPA Draft Method 1630, section 11.

2.1.1.1 An alternative to distillation, direct ethylation, has been developed and validated. [redacted]

2.1.2 Sediment samples are prepared by dichloromethane (DCM) extraction.

2.1.3 Biota samples are prepared by alkaline digestion [redacted], which can then be followed with distillation if a lower detection limit is required.

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2.2 MeHg is determined by an improved method (Liang, Bloom, and Horvat 1994). The prepared sample is buffered [redacted] using acetate or citrate buffer, the MeHg is then ethylated [redacted]. The ethylation reagent adds an ethyl group to the methyl mercury compound (CH_3Hg^+ $^-C_2H_5$) making volatile methylethyl mercury, it also adds two ethyl groups to the Hg^{2+} making volatile diethyl mercury. The volatile mercury species are liberated from the liquid and collected by purging with dry, Hg free nitrogen into a pyrex tube filled with Tenax™. The ethyl mercury derivatives are then thermally desorbed with Hg free argon and transferred to a GC column held in an oven [redacted], which separates the species chromatographically by mass. The ethylated Hg compounds are pyrolized at [redacted] to Hg (0), then quantified by a cold vapor atomic fluorescence spectrophotometer (CVAFS). This method can by applied for the determination of MeHg in a variety of sample matrices and has been demonstrated as being very sensitive, precise, and accurate. Good agreement was obtained for the determination of MeHg in standards, CRMs and real samples in comparison to the manual system used at Brooks Rand Labs and less variability was seen in the automated system.

3.0 Definitions

3.1 A partial list of definitions is presented below. Most definitions can be found for specific terms in the sections where they are first mentioned. Many of the definitions mentioned in this method are based on those found in the glossary for EPA Method 1630. Please refer directly to this method for a more detailed list.

3.1.1 May: This action is allowed but not required.

3.1.2 May Not: This action is prohibited.

3.1.3 Must: This action is required.

3.1.4 Shall: This action is required.

3.1.5 Should: This action is suggested, but is not required.

4.0 Interferences

[redacted]If properly applied, the distillation procedure will remove most if not all of the significant interferences. However, the concentration of hydrochloric acid (HCl) in the solution will affect the distillation of methyl mercury from the solution. [redacted]

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4.1.1 It has been found that there are few interferences in most aqueous samples and the direct ethylation technique can be used.

4.1.2 EPA Method 1630 dictates that fresh water samples must be preserved with between 0.3% to 0.5% (v/v) 11.6 M HCl (BRL preserves fresh water samples with 0.4% (v/v) 11.6 M HCl) and that salt water samples must be preserved with between 0.1% to 0.2% (v/v) 18 M sulfuric acid (H_2SO_4) (BRL preserves salt water samples with 0.2% (v/v) 18 M H_2SO_4).

4.2 Samples must not be preserved with nitric acid as it may cause partial decomposition of the analyte during distillation.

4.3 Positive artifact is possible with the distillation of samples that are high in inorganic mercury. Ambient organic matter may methylate 0.01% to 0.05% of the ambient inorganic mercury during distillation. In inorganic mercury contaminated waters this can significantly affect the results for methyl mercury. Solvent extraction may be preferable to distillation in samples that are high in divalent mercury (Hg(II)).

4.4 Residual DCM in sediment extractions has been shown to interfere with the recovery of methyl mercury. All DCM must be evaporated from the final back extraction to ensure that suppression does not occur. Strict adherence to the instructions found in Section 9.4.1 of this SOP should ensure that all DCM is removed from sample preparations.

4.5 Presence of the aqueous phase of the sediment prep after phase separation to isolate the organic phase can also cause interference. Strict adherence to the instructions found in Section 9.4.1 of this SOP should ensure that all DCM is removed from sample preparations.

4.6 Care must be taken when making the [redacted] sodium tetraethylborate solution [redacted]

4.7 Refer to EPA Method 1630, Section 4.0, for a detailed account of possible contamination routes, interferences to the analysis, and how these are avoided or minimized at BRL.

5.0 Safety

5.1 Refer to EPA Method 1630, section 5.0, for safety issues associated with the use of this method.

5.2 Chronic mercury exposure may cause kidney damage, muscle tremors, spasms, personality changes, depression, irritability, and nervousness. Organo-mercurials may cause permanent brain damage. Because of this, only highly trained personnel familiar

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with the dangers and precautions to take when working with mercury compounds should ever handle standards and/or high level samples.

5.3 Material safety data sheets (MSDSs) are maintained for all chemicals used in this method. Scanned MSDS sheets are stored on the server and can be located by either chemical name or by CAS number.

5.4 Refer to the latest revision of the Chemical Hygiene Plan (CHP) for additional safety precautions and required protective equipment.

6.0 Apparatus and Materials Used at BRL

6.1 Refer to EPA Method 1630, Section 6.0 for a list of materials used in the method employed at BRL.

6.2 Routine preventative maintenance for the equipment used in this procedure is described in detail in the standard operating procedure BR-1205 (Preventative Maintenance).

6.3 Detailed instructions for the decontamination of bottles and other equipment are described in BRL SOPs BR-0400 and BR-0404.

6.4 Specific equipment used at BRL is listed below. Any modifications to EPA Method 1630 are described and explained.

6.4.1 Autosampler: An AI Scientific septum piercing autosampler with 168 slots is used at BRL. Other autosamplers may be used if they are compatible with the Guru software, have septum piercing capabilities, and can hold the 40 mL glass vials.

6.4.1.1 Reaction vessels: A 40 mL flat bottomed amber glass vial with a Teflon lined septum cap is used as the reaction vessel. Vials similar to I-Chem SB46-0040 or EP Scientific 341-40A are used.

6.4.2 MERX Methylmercury Autoanalyzer: The MERX methylmercury autoanalyzer is designed and manufactured by BRL. For a diagram, see Figure 1.

6.4.2.1 The Purge and Trap Module:

6.4.2.1.1 A purge vessel, a 50 mL glass tube with a port coming out of the top and another port coming off the base is used as the purge vessel. Mercury free nitrogen is purged into the reaction vessel forcing the sample into purge vessel from the port at the bottom. The nitrogen continues to pass through both the reaction vessel and the purge vessel during the entire purge time. As the sample is purged, the volatile mercury species are swept from the

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sample onto the preconcetration trap via the port at the top of the purge vessel.

6.4.2.1.2 The preconcentration trap is a Tenax trap measuring 10 cm long, 6.4 mm outside diameter x 4.0 mm inside diameter that is kinked at both ends and used for the collection of purged organomercury species.

6.4.2.2 The GC and Pyro Module: Isothermal gas chromatography system consisting of a GC column, GC oven, and pyrolitic column. For a diagram of the system see Figure 2.

6.4.2.2.1 Gas Chromatography (GC) Column: A GC column [redacted] packed with OV-3 and held at a constant [redacted] temperature is used. Under a flow of high purity argon, organomercury species desorbed from the preconcetraion trap are carried by argon gas through the GC column where they are separated by mass.

6.4.2.2.2 Pyrolitic Column: The pyrolitic column is a quartz tube [redacted]. After GC separation, species pass through the pyrolitic column where they are thermally decomposed to elemental mercury before going through the detector.

6.4.3 Atomic fluorescence spectrophotometer (BRL part #AF-03): CVAFS systems are built by BRL (BRL Model III). Refer to the "Brooks Rand, LLC Model III Operations Manual" for instrument operating instructions.

6.4.4 Recorder: BRL uses direct data acquisition with the BRL Guru™ integration software instead of a chart recorder or integrator as described in EPA Method 1631E, section 6.6. Refer to the "Brooks Rand LLC Model III Operations Manual" for Guru™ software/integrator operating instructions and system requirements. Use of this integration software is faster, eliminates the expense of chart recorders and/or integrators, allows for storage of data in electronic form, and eliminates possible transcription errors.

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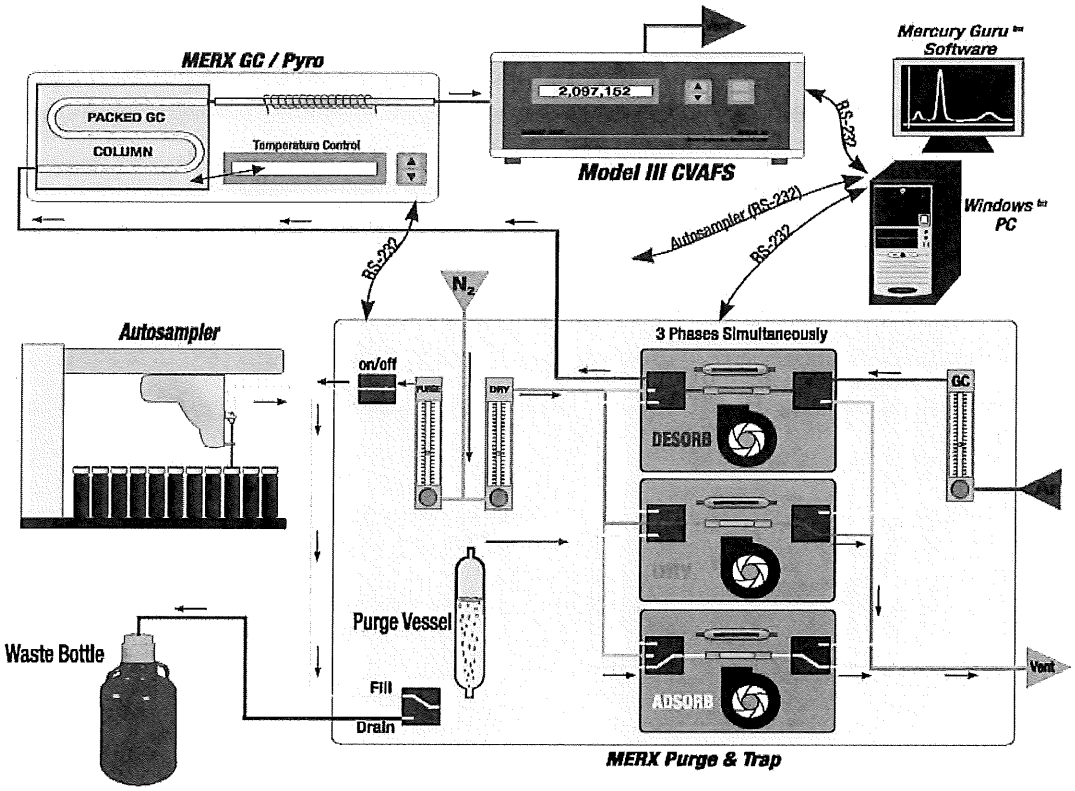

Figure 1. Diagram of sample flow path and connections for MERX MeHg analytical system.

7.0 Standards and Reagents

7.1 Refer to EPA Method 1630, Section 7.0 for a list of standards and reagents employed at BRL.

7.2 Water: Deionized water (DIW) is monitored on a daily basis during calibration of the instrument as part of the calibration blanks and the recoveries of the calibration standards.

7.3 MeHg Standard Solutions: [redacted]

7.3.1 Standard stock solution: [redacted]

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7.3.2 Intermediate stock solution: [redacted]

7.3.3 Working standard: [redacted]

7.3.4 Working standard: [redacted]

7.3.5 Daily standard: [redacted]

7.3.6 Independent calibration verification (ICV) solution: [redacted]

7.4 n-propylmercury (n-prHg) standard solutions

7.4.1 Standard stock solution: A 10,000 ng/mL n-propyl mercury standard [redacted]

7.4.2 Working standard: 100 ng/mL n-prHg. [redacted]

7.4.3 Daily standard: 1.0 ng/mL n-prHg. [redacted]

7.5 Sodium tetraethylborate ($NaBEt_4$) solution: [redacted]

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[redacted]

7.6 Sodium acetate buffer: [redacted]

7.7 Citrate buffer: [redacted]

7.8 Methanolic potassium hydroxide solution: [redacted]

7.9 Gases: All gasses are passed through a gold-coated sand trap to remove traces of mercury prior to use.

7.9.1 Argon used as the carrier gas from trap desoption, through the GC and pyrolitic column to the detector and is from cryogenic bleed off.

7.9.2 Nitrogen used as a purge gas for sweeping derivatives from a bubbler is plumbed from cryogenic bleed-off.

7.10 [redacted] potassium chloride (KCl) / [redacted] L-Cysteine solution: [redacted]

7.11 11.6 M hydrochloric acid (HCl): [redacted]

7.12 18 M sulfuric acid (H_2SO_4): [redacted]

7.12.1 9M H_2SO_4: [redacted]

7.13 Potassium bromide/sulfuric acid solution (KBr/H_2SO_4): [redacted]

7.14 [redacted] copper sulfate solution ($CuSO_4$): [redacted]

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7.15 DCM (methylene chloride): DCM (HPLC Grade) may be purchased from an authorized vendor.

8.0 Sample Collection, Preservation, and Handling

8.1 Refer to EPA Method 1630, Section 8.0 and EPA Method 1669 (*Sampling Ambient Water for Determination of Trace Metals at EPA Water Quality Criteria Levels*) for a detailed description of sample collection, preservation, and storage methods.

8.2 Aqueous samples may be collected in fluoropolymer, FLPE, or glass containers with fluoropolymer lined lids. Aqueous samples should be maintained at 0 – 4 °C from the time of collection until preservation. Aqueous samples must be preserved within 2 days of collection. Freshwater samples are preserved with 4 mL/L of pre-tested concentrated HCl. Saline samples (salinity > 10 ppt) and urine samples are preserved with 2 mL/L of pre-tested 18 M H_2SO_4. Preserved samples are stable for up to 6 months if kept in the dark and cool. BRL defines "cool" as ≤ 12 °C. As long as a sample is field preserved and received by BRL ≤ 12 °C, then no qualification of the data is necessary. Once received by BRL, the policy is to store all aqueous MeHg samples from 0 – 4 °C.

8.3 Biota and sediment samples may be collected in glass or HDPE containers. Solid samples must be maintained at 0 – 4 °C from the time of collection until receipt by BRL. Upon receipt, solid samples are moved to freezers for storage. Solid samples may be held for at least 1 year if kept in the dark at < -15 °C.

> *NOTE: Due to uncertainty inherent in accurately measuring sample temperatures, it is understood that the measured temperature may be as much as ±2 °C from the actual temperature. Therefore, as long as water samples remain unfrozen, ±2 °C are allowed beyond the above ranges without requiring qualification of the data.*

9.0 Sample Preparation

9.1 Refer to EPA Method 1630, Section 11.0 for a detailed description of the preparation of samples. Depending on the purposes and definitions of investigations of mercury biogeochemistry cycling, samples are prepared in the following methods prior to analysis.

9.2 Preparation of aqueous samples for MeHg analysis: Two isolation methods, distillation and solvent extraction, have been used at BRL for the determination of MeHg in aqueous samples. Good agreement was obtained in the comparison of the two methods for most water samples studied: For organic rich and/or high level sulfide containing samples, the distillation showed some advantages over the solvent extraction method with higher recoveries (85 ± 4%, Horvat, Bloom, and Liang, 1993). In addition, extraction consumes large quantities of organic solvent, which can result in environmental

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contamination. Therefore, if preparation of aqueous samples in needed, distillation is the preferred preparation method for aqueous samples at BRL. Direct ethylation has shown recoveries equivalent to distillation and may also be used.

9.2.1 Distillation of aqueous samples:

Reagents: [redacted] KCl in [redacted] L-Cysteine, 9 M H_2SO_4

Distillation devices: Vials and caps for distillation and distillate collection are made of fluoropolymer obtained by Savillex Corporation, USA. Caps have 1/8" ports for friction fit 1/8" fluoropolymer tubing.

Distillation procedures: An aliquot of water sample, typically 50 ml ± 1 mL, is transferred into a 60 mL fluoropolymer vial (for high MeHg concentration samples, smaller sample sizes should be used, but bring the final volumes to a known volume near 50 mL with [redacted] HCl solution). [redacted] Urine samples can be batched with other water samples but at least one urine sample should have QC performed.

[redacted]

All blanks, including blank spikes (BS), should be prepared by weighing out 50 mL of a [redacted] HCl solution then spiked if appropriate. Add [redacted] of the [redacted] KCl/[redacted] L-Cysteine solution and [redacted] of 9 M H_2SO_4 (9 M H_2SO_4 is not added to samples preserved with H_2SO_4). Start the distillation immediately after addition of reagents at a nitrogen flow rate of approximately [redacted] (Note: all rotometers must be within ± 3 $mL \cdot min^{-1}$ of one another) and at a heating block temperature of [redacted].

The distillate is collected in a 60 mL fluoropolymer vial containing [redacted] chilled DIW, which must be cooled in an ice-water bath prior to the beginning of the distillation. [redacted] Bring the final volume of the receiving vial to the 58 mL mark with DIW. Depending on its MeHg

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concentration, transfer an aliquot of the distillate into the methylation reaction vessel for analysis as described in section 10.3.

NOTE: [redacted]

[redacted]

Besides the typical distillation of aqueous samples, BRL also offers "ultra low-level" distillation. To achieve the lower detection limits associated with the ultra low-level method, the vials and tubing used in the distillation must be rigorously cleaned with BrCl followed by heating in the oven with 0.8% $NH_2OH \cdot HCl$ and triple rinsing. Refer to the bottle washing SOP (BR-0400) for a full description of the cleaning procedures for equipment used in this method.

9.2.2 For direct ethylation, samples are preserved within 48 hours of collection as normal. There is no further sample preparation necessary. [redacted]

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9.3 Preparation of biological materials for MeHg.

9.3.1 Alkaline digestion of biota samples: Weigh [redacted] of biological material (wet, homogenous) into a 2.5 mL fluoropolymer vial. Add [redacted] KOH methanol solution and cap the vial tightly. Digest the sample in an oven [redacted] After digestion, bring the final volume to 2.5 mL with methanol prior to analysis. [redacted] The digestion may be scaled up if larger volumes are required. [redacted]

9.3.2 Distillation (following alkaline digestion): If there is matrix interference or if a lower detection limit is desired, the alkaline digestate can be distilled (Horvat, Bloom, and Liang, 1993). Distillation allows for up to 2.0 mL of the digestate to be analyzed [redacted], thereby significantly reducing the detection limits for the analysis of MeHg in biota samples.

[redacted]

9.4 Preparation of sediments and soils for MeHg.

[redacted] Solvent extraction for sediments: Sediment samples should be extracted to avoid the potential for artifact formation of MeHg during distillation. [redacted] sediment sample is accurately weighed into a clean 30 mL fluoropolymer vial. Only for surrogate correction, each sample is spiked with [redacted] ng/mL n-propyl mercury standard. [redacted] the KBr/H_2SO_4

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solution (Section 7.13) and [redacted] $CuSO_4$ solution (Section 7.14) are added to the sample. [redacted] DCM are accurately weighed and added. The sample is [redacted] shaken [redacted] The sample is then passed through phase separating filter paper so that only the organic layer is collected. The organic layer is collected directly to a triple rinsed, pre-weighed 125 mL Teflon® bottle. The weight of the collected organic layer is measured and approximately 50 mL of DIW is added to the bottle along with a couple of Teflon® boiling chips to help prevent the DCM from "bumping" during the back extraction. [redacted]

NOTE: [redacted]

The sample is then diluted to 100 mL with additional DIW. [redacted] The extracted sample is analyzed following the same procedure used for the analysis of water distillations.

MeHg Sediment Prep step by step instructions

[redacted]

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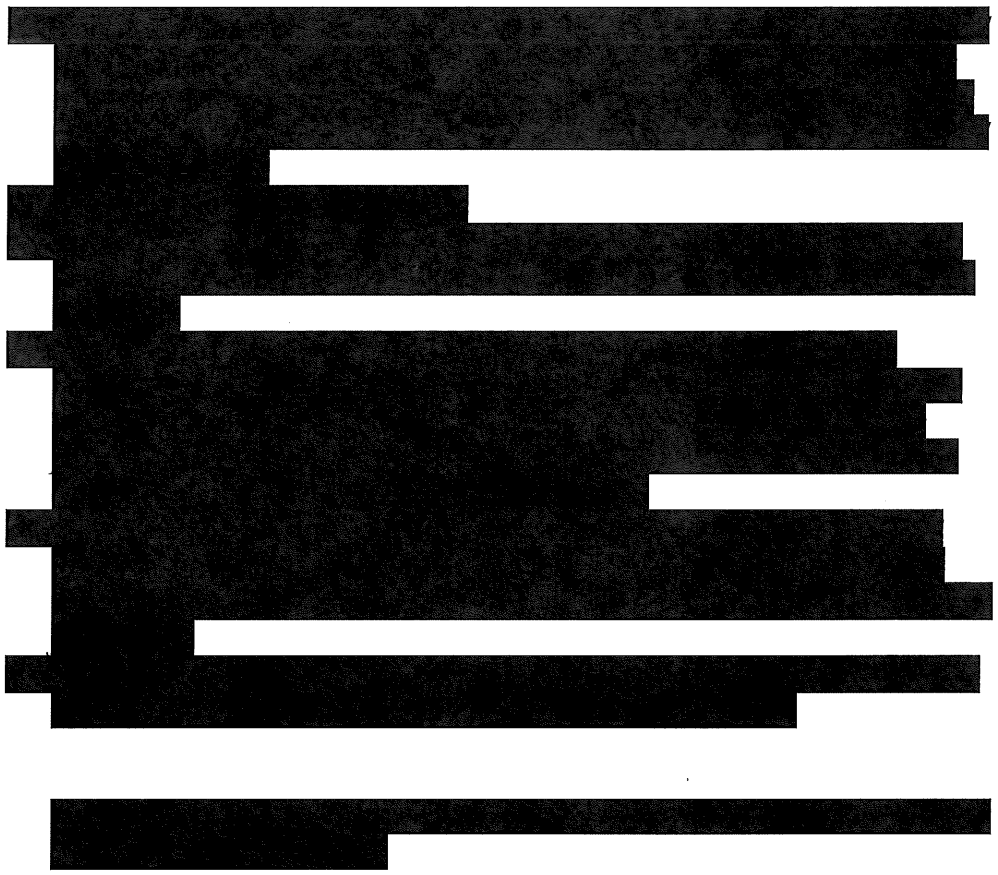

9.5 Holding times for sample preparations.

9.5.1 Distillations: Water and sediment distillates and distillates of biota digestates are stable for up to 48 hours if stored at room temperature and in the dark. Distillates must not be refrigerated or frozen.

9.5.1.1 EPA Method 1630 specifies that distillates with a pH <3.5 must be discarded. BRL has found that good recoveries can still be obtained for these samples if an adequate pH is obtained prior to ethylation.

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[redacted]

9.5.2 Extractions: Water and sediment extractions (once back extracted into water) are stable for up to 48 hours if stored at room temperature in the dark.

9.5.2.1 The holding time limit for intermediate organic extraction (prior to back extraction) has been examined and was shown to be stable for up to one week. Currently, Brooks Rand Labs performs the entire extraction procedure within one day unless explicit approval is given in advance by the Lab Manager.

9.5.3 Digestions: Biological digestates are more stable than distillates and may be stored up to 30 days prior to analysis. [redacted]

10.0 Instrument Calibration and Sample Analysis

10.1 Refer to EPA Method 1630, Sections 10.0, 11.0, and 12.0 for a detailed description of the analysis of samples and the calculation of results.

10.2 Instrument Calibration: BRL follows EPA method 1630, Section 10.0 for the instrument calibration with the same exceptions as for sample analysis. Standards, typically 0.5, 1, 2, 10, 50, 250, and 1000 pg MeHg are added into reaction vessels containing 40 mL of DIW and buffer. Two different buffer types are used, 300 µL of 2 M acetate buffer or 2 mL of citrate buffer. Only the ethylation blanks analyzed prior to the calibration standards are used for blank correcting the calibration and sample results. Any other ethylation blanks analyzed following the calibration standards are used only to check for carryover or other potential system contamination.

10.3 Instrumental Analysis: BRL has adopted the following modifications.

For samples, add appropriate sample volumes plus DIW as necessary for a final volume of 40 mL (for sample preparation see Section 9 of this SOP). Some acid can be carried over during distillation causing some distillates to have a low pH (< 4). In that event, follow instructions in section 9.5.1.1 to bring the final pH to [redacted], which is the optimum pH for ethylation. An aliquot of [redacted] of $NaBEt_4$ is added, a squirt bottle of

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DIW is used to fill the vial until there is a convex meniscus, the sample is tightly capped, shaken, then placed in the appropriate position on the autoanalyzer.

Note: Based on a study conducted at BRL, it has been determined that samples can be analyzed up to 4 days after ethylation and yield acceptable recoveries. [redacted]

Place the samples in the autosampler. Under the "Automation" tab in Guru, make sure all settings are correct then press "Start Batch". It will commence a 10 minute trap blanking cycle then begin to take up sample.

Peak integration is begun in conjunction with the heating of the Tenax trap. The typical heating time for the MERX system is [redacted]. The organomercury species are desorbed and carried through the GC column that is held in an oven [redacted]. The species elute in order of increasing molecular weight, pass through the pyrolitic column, held at approximately [redacted] at which point all organomercury species are converted into Hg(0), and detected by CVAFS. The reaction vessels are used only once then discarded.

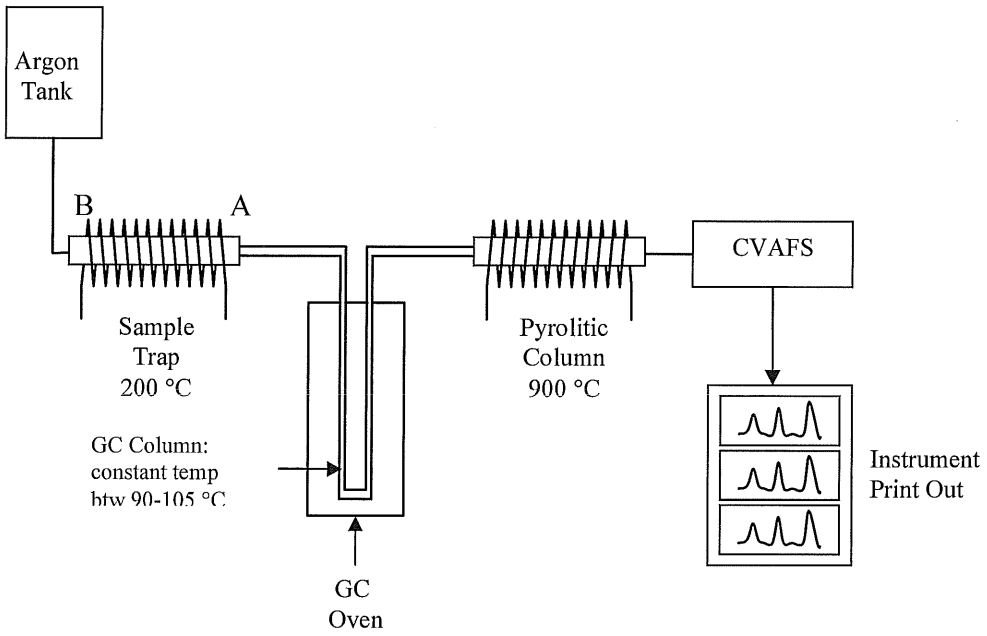

Figure 2: A schematic diagram of the isothermal Gas chromatograph system

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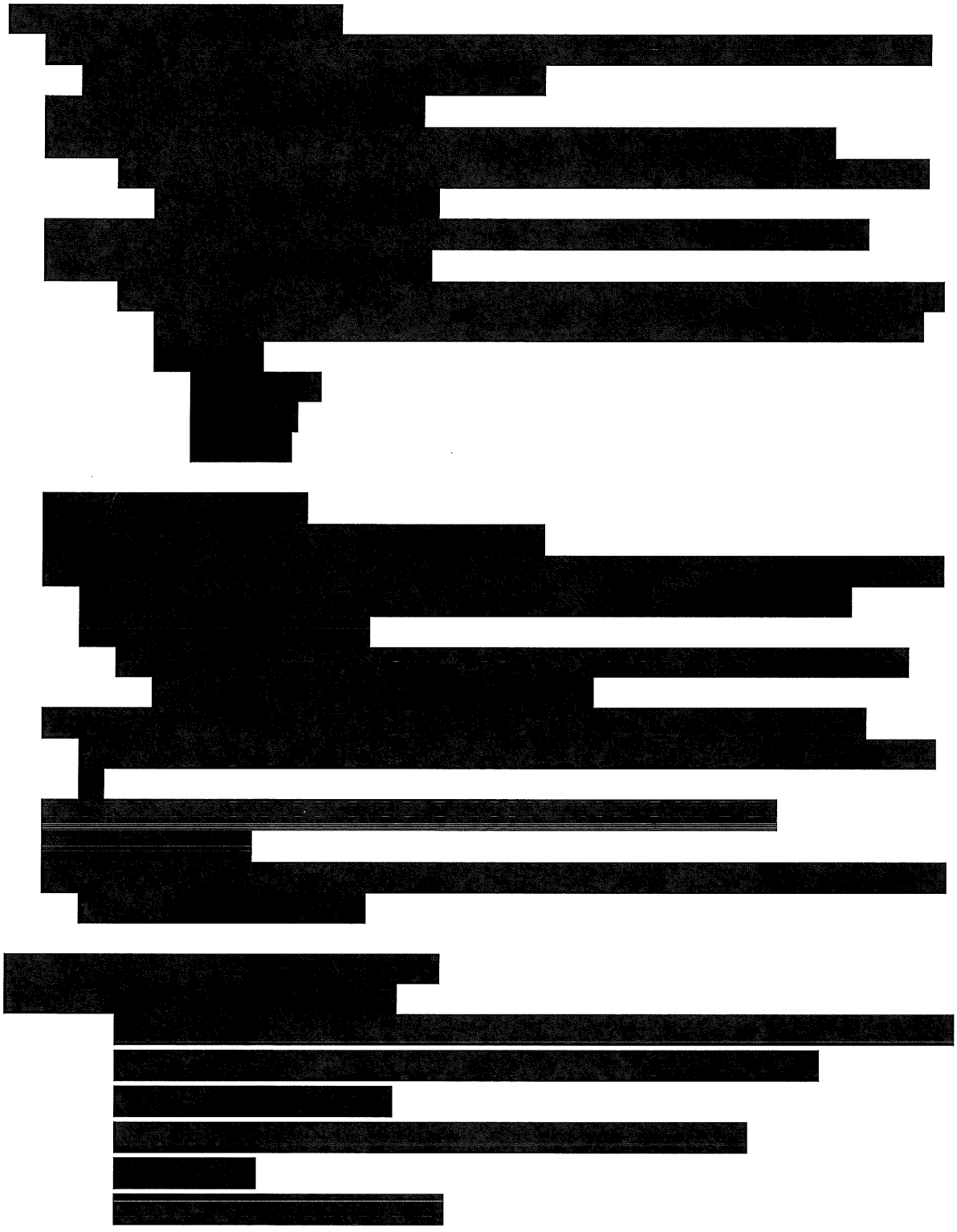
Quick MeHg MERX Analysis Guide



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[redacted]

[redacted]

11.0 Calculations

11.1 All instrument peaks are integrated using Hg Guru™ software. This integration is automated; however, there are occasions when Guru™ will not properly integrate a peak. This is most common with small peaks, abnormally shaped peaks, or peaks with excessive tailing. When a peak is not properly integrated by Guru™, the analyst may manually integrate or adjust the integration of the peak using the Guru™ software (refer to the Guru™ user manual). When manually integrating or adjusting the integration of a peak, the analyst must note that the peak was manually integrated and the reason for the manual integration. This is done on the analytical benchsheet at the time of the manual integration. The final data reviewer is authorized to accept or reject the manual integrations. If they are accepted, the manually integrated peaks are printed and signed and dated as approved by the final data reviewer. The final peak integrations are used to calculate the reported results.

11.2 BRL uses the following formulas for the calculation of monomethyl mercury in a given sample.

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11.2.1 Mean Calibration Coefficient:

A calibration coefficient (CF) is calculated for each standard used in the calibration as follows:

$$CF = CS_{pgMeHg} / (CS_{PH} - EB_{PH})$$

Where CS_{pgMeHg} is the calibration standard measured in picograms of methyl mercury, CS_{PH} is the peak height obtained during the analysis of the standard, and EB_{PH} is the mean peak height obtained during the analyses of all of the ethylation blanks that were analyzed prior to the calibration standards. The mean calibration coefficient (CF_{avg}) is then calculated for all of the standards used in the calibration.

11.2.2 Measured methyl mercury in the sample preparation:

The amount of methyl mercury present in the analyzed volume of the sample preparation is calculated using the equation:

$$MeHg_{measured\ pg} = (A_{PH} - EB_{PH}) \cdot CF_{avg}$$

Where A_{PH} is the peak height obtained during the analysis of the sample preparation.

11.2.3 Total methyl mercury in the sample preparation:

The total amount of methyl mercury present in the sample preparation is calculated using the equation:

$$MeHg_{total\ pg} = [(MeHg_{measured\ pg}) / V_A] \cdot V_D$$

Where V_D is the final dilution volume of the sample preparation in mL and V_A is the volume analyzed of the sample preparation in mL.

11.2.4 Concentration of methyl mercury in the sample:

The final concentration of methyl mercury in the sample is calculated using the equation:

$$MeHg_{conc} = (MeHg_{total\ pg} - MB_{total\ pg}) / V_o$$

Where $MB_{total\ pg}$ is the average total picograms of methyl mercury present in the method blanks and V_o is either the volume of the prepared sample measured in mL (aqueous samples) or the weight of the prepared sample measured in mg (solid samples). Therefore, the final concentration of methyl mercury in the sample is reported in units of ng/L for aqueous samples and in units of ng/g for solid samples.

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NOTE: The total picograms of methylmercury present in each method blank is calculated using the same formula used to calculate the total picograms of methyl mercury in the sample preparation.

Sediment and soil results are typically dry weight corrected by dividing the wet weight result by the percent total solids result. Biota results are typically reported on a wet weight basis, but can be reported dry weight corrected upon request.

11.2.5 Empirically derived correction factor

BRL routinely recovery corrects results for distilled samples, as per EPA Draft Method 1630, to account for the fact that the distillation procedure is not 100% efficient in recovering methyl mercury. Results are multiplied by an empirically derived correction factor that is based on the average recovery of the appropriate quality control sample (Laboratory Fortified Blanks for aqueous distillates and the certified reference material (CRM) BCR 580 (Marine Sediment) for sediment distillates). If an appropriate QCS sample is not available, the correction factor is based on the average recovery of the spikes made to samples with a similar matrix to the sample of concern.

The correction factor is calculated using the following equation:

$$F = 100 / R$$

Where F is the empirically derived correction factor and R is the running mean of the recoveries of the last 30 quality control samples or matrix spikes. The empirically derived correction factor is updated quarterly or any time that there is a significant change in performance.

BRL does not use the IPR and CCV samples to calculate the correction factor since, unlike the client samples and quality control samples, these samples are not distilled.

No correction factor is necessary for samples that are analyzed by direct ethylation.

11.2.6 Surrogate spike correction

11.2.6.1 Sample preps can be spiked with n-propylmercury that is used as surrogate spike.

11.2.6.2 N-prHg concentrations are calculated in the same way as the MeHg in the samples.

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11.2.6.3 Soil and sediment samples can be corrected by the surrogate concentration by the following equation:

$$\text{Final MeHg}_{\text{conc f}} = \text{MeHg}_{\text{conc i}} / R_{\text{n-prHg}}$$

Where $\text{MeHg}_{\text{conc f}}$ is the surrogate recovery corrected concentration. $\text{MeHg}_{\text{conc I}}$ is the initial concentration of MeHg before recovery correction. $R_{\text{n-prHg}}$ is the percent recovery of the n-propylmercury expressed as a decimal.

Percent recovery of n-prHg is determined by the following equation:

Percent Recovery = (spiked sample result (conc.)) / (amount spiked)

12.0 Quality Control

12.1 Refer to EPA Method 1630, Section 9.0 for a detailed description of the quality control procedures employed at BRL for this method.

12.2 All quality control data should be maintained and available for easy reference and/or inspection.

12.3 Each analyst must perform an initial demonstration of capability (IDOC) for the analysis of methyl mercury prior to the analysis of any client samples. The IDOC consists of an initial precision and recovery (IPR) study following the procedure in EPA Draft Method 1630, Section 9.2.2. The acceptance criteria and run sequence for the IDOC can be found in Table 3 in Section 17 of this SOP.

12.4 Calibration data must be composed of a minimum of 1 ethylation blank (BRL analyzes 3 ethylation blanks prior to analyzing the calibration standards) and a minimum of 5, preferably 7, standards (See Section 7.3 and 10.2 of this SOP for the standards used to calibrate instruments at BRL). Such a calibration should be run daily, prior to analysis, or whenever stock standards have been remade, conditions have changed, or initial calibration check (ICV) or ongoing precision and recovery (CCV) as defined in Section 12.5 do not yield acceptable recoveries.

12.5 The CCV solution prepared by spiking the reaction vessel with 25 pg methyl mercury using the calibration standard and followed by an ethylation blank must be analyzed after every 10 client samples and at the end of the analysis of each analytical batch. Additionally, BRL analyzes an independent calibration check (ICV) solution prepared by performing a KOH/Methanol digest of the certified reference material NIST 1946 (Refer to Section 7.3.6) and spiking this solution directly into the reaction vessel prior to the analysis of each analytical batch. The criterion for the recovery of the CCV

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solution is 67-133% and the recovery criterion for the recovery of the ICV solution is 80-120%. All ethylation blanks must contain no more than the level of methyl mercury found in the low calibration standard.

12.6 Matrix spike/matrix spike duplicate (MS/MSD) analysis should be performed once per every 10 client samples or once per batch, whichever is greater. A matrix spike sample is defined as an aliquot of homogenized sample that has a known amount of analyte added to it. The target spiking concentration is 2 – 5 times the level of the native sample or 5 times the sample specific MRL, whichever is greater. If there is no historic data on which to base the spike concentration, then the following default spiking levels should be used:

Aqueous Samples:	1 ng/L
Sediment Samples:	2 ng/g
Fish Samples:	750 ng/g
Other Biota:	200 ng/g

The matrix spike sample is processed through the entire preparation and analytical procedure. Bias is then determined by calculating the percent recovery of the known amount using the following formula:

Percent Recovery = 100 * (spiked sample result (conc.) - sample result (conc.)) / (amount spiked)

The criterion for spike recovery is determined by control charts and is different for each matrix type. The specific matrix spike recovery criteria for each matrix type and preparation procedure can be found in Tables 5 and 6 in Section 17 of this SOP.

The relative percent difference between the MS and the MSD is calculated using the following formula:

$$RPD = 200 \cdot (\,|\,MS\text{-}MSD\,|\,) / (MS + MSD)$$

The RPD for the MS/MSD pair must meet the criterion for each of the matrix types found in Tables 5 and 6 in Section 17 of this SOP.

12.7 Method duplicates are prepared and analyzed upon client request. For solid matrices method duplicates should be performed in conjunction with the MS/MSD samples and whenever the heterogeneity of a sample is deemed great enough that it may cause problems with the analysis of the sample. The relative percent difference (RPD) between duplicate samples is calculated using the same formula as used to calculate the RPD between the MS and MSD samples. The specific RPD criteria for each matrix type and preparation procedure can be found in Tables 5 and 6 in Section 17 of this SOP. If the acceptance criterion for duplicate analysis is not met for either samples or matrix spike samples, then the system performance is unacceptable. Associated samples must be qualified or the problem must be corrected and the samples reanalyzed.

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12.8 Field duplicates are analyzed at the client's discretion. The acceptance criterion for field duplicate analysis is the same as that used for method duplicate analysis. The client must be notified immediately anytime that the acceptance criterion for field duplicates is not met.

12.9 Four method blanks (MB) should be prepared and analyzed with each batch. For water distillation batches, the method blanks are prepared using reagent water acidified to 0.4% HCl in order to simulate the preservation of the samples. For sediment and biota batches, the method blanks are prepared just using the reagents. All method blank results must meet the acceptance criteria set forth in Tables 5 and 6 of Section 17.

12.10 Blank spikes (BS) are prepared and analyzed with each distillation batch at a minimum frequency of one per batch. BSs are prepared by spiking a method blank sample with the calibration standard at a concentration of approximately 1.0 ng/L. The BS is then distilled as per an aqueous sample. The acceptance criterion for the recovery of the BS (recovery corrected) is identical to the acceptance criterion for the recovery of CCV samples.

12.11 Appropriate certified reference materials (CRM) for MeHg are prepared for all batches containing tissue or sediment samples. It is BRL policy to prepare one CRM with every solid batch. Two entirely different CRMs may be prepared if different matrix types are analyzed together. Criteria for CRM recoveries are determined by control charts. If control charts are not available then CRM results should be within 35% of the certified value (following recovery correction) for the analysis to be considered valid. CRM accuracy results not meeting this criterion shall be reprepared and reanalyzed or qualified at the discretion of the Laboratory Director. Currently, there are not any water based CRMs available.

12.12 Surrogate spikes are used to evaluate the efficiency of the procedure. Surrogates must be performed in every sample if direct ethylation is performed. They also may be used with sediment batches to efficiency correct the data. Refer to Tables 5 and 6 for acceptance criteria regarding surrogate spike recoveries.

13.0 Method Performance

13.1 Refer to EPA Method 1630, section 13.0, for information regarding the verification of this method.

13.2 The detection limits reported in Table 1 were achieved by performing a full MDL study as described in 40 CFR 136, Appendix B. The warning and control limits listed in Table 2 show the limits achievable at BRL.

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14.0 Pollution Prevention

14.1 Refer to EPA Method 1630, section 14.0, for EPA recommendations regarding pollution prevention techniques.

14.2 Whenever feasible, lab personnel should use pollution prevention techniques to limit waste generation. The cost involved in purifying acids makes such recycling unpractical at BRL. Instead, every effort is made to reduce volumes necessary to still produce the best possible results. When making standards, they should be prepared in volumes consistent with their use in the laboratory to minimize the volume of expired standards to be disposed.

15.0 Waste Management

15.1 Refer to EPA Method 1630, section 15.0, for information and references related to managing waste produced by application of this method.

15.2 All waste is disposed of in accordance with state and federal regulations either by sewer disposal (only if concentrations are below the King County sewer limits) or through a licensed and bonded hazardous waste disposal facility such as Philips Services.

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16.0 References

16.1 Liang, L.; Bloom, N.S.; and Horvat, M. (1994) "Simultaneous Determination of Mercury Speciation in Biological Materials by GC/CVAFS After Ethylation and Room-Temperature Precollection." *Clin. Chem.* 40/4: 602-607.

16.2 Bloom, N.S.; Colman, J.A.; and Barber, Lee. (1997) "Artifact Formation of Methyl Mercury during Aqueous Distillation and Alternative Techniques for the Extraction of Methyl Mercury from Environmental Samples." *Journal of Analytical Chemistry* 358:371-377.

16.3 Bloom, N.S. (1989) "Determination of Picogram Levels of Methylmercury by Aqueous Phase Ethylation, Followed by Cryogenic Gas Chromatography with Cold Vapor Atomic Fluorescence Detection." *Canadian Journal of Fisheries and Aquatic Sciences.*

16.4 Long, S.J.; Scott, D.R.; and Thompson, R.J. (1973) "Atomic Absorption Determination of Elemental Mercury Collected from Ambient Air on Silver Wool." *Anal Chem.* 45: 2227-2233.

16.5 Horvat, M.; Bloom, N.; and Liang, L. (1993) "A Comparison of Distillation with Other Current Isolation Methods for the Determination of Mercury Compounds in Low Level Environmental Samples, Part I: Sediments." *Analytica Chimica Acta* 281:135-152.

16.6 Horvat, M.; Liang, L.; and Bloom, N. (1993) "Comparison of Distillation with Other Current Isolation Methods for the Determination of Mercury Compounds in Low Level Environmental Samples., Part II: Waters." *Analytica Chimica Acta* 282:153-168.

16.7 Horvat, M.; May, K.; Stoeppler, M.; and Byrne, A.R. (1988) *Appl. Organomet. Chem.* 2: 515.

16.8 EPA Draft Method 1630 (January 2001) "Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and CVAFS."

16.9 EPA Method 1669 (April 1995) "Sampling Ambient Water for Trace Metals At EPA Water Quality Criteria Levels."

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17.0 Tables and Benchsheets

Table 1 Current method detection limits and minimum levels determined at BRL for the analysis of methyl mercury using EPA Method 1630

Matrix	Preparation Method	Default Mass/ Volume	Default Final Volume	Default Analysis Volume	Method Detection Limit (MDL)[1]	Limit of Quantitation (LOQ)
Water	Distillation	50 mL	[redacted]	[redacted]	0.020 ng/L	0.050 ng/L
Water (ultra-low)	Distillation	50 mL	[redacted]	[redacted]	0.010 ng/L	0.025 ng/L
Sediment/ Sludge	Extraction	2.5 g	[redacted]	[redacted]	0.008 ng/g	0.025 ng/g
Biota	Digestion	100 mg	[redacted]	[redacted]	1.0 ng/g	3.0 ng/g
Biota	Digestion/ Distillation	100 mg	[redacted]	[redacted]	0.07 ng/g	0.20 ng/g

NOTES:
1. MDL as determined by the procedure 40 CFR Part 136, Appendix B. MDL and ML reported here for distillations are for recovery corrected results.
2. The ultra-low method requires rigorously cleaned distillation vials and a lower calibration achievable only on the auto-analyzer system.

Table 2 Summary of recent control chart data ending May 2012 (minimum of 30 data points) for the analysis of methyl mercury using EPA Method 1630

QA Sample	Matrix	Mean[1] Recovery (%)	Warning Limit (%) ± 2 StDev[2]	Control Limit (%) ± 3 StDev[2]
ICV	ALL	106	9	13
CCV	ALL	100	13	20
Matrix Spikes	Water	104	25	37
Matrix Spikes[3]	Sed/Sludge	99	33	50
Matrix Spike	Biota	111	27	41
BS	Water	99	23	35
CRM[3,4]	Sed/Sludge	111	24	36
CRM[5]	Biota	108	27	41
QA Sample	**Matrix**	**Mean RPD**	**Warning Limit (%) Mean ± 2 StDev**	**Control Limit (%) Mean ± 3 StDev**
Duplicates	Water	6	11	17
Duplicates[2]	Sed/Sludge	11	19	28
Duplicates	Biota	9	14	21

NOTES:
1. Recoveries for distillations (water samples) have been recovery corrected using an empirically derived correction factor.
2. Warning and control limits are expressed around the mean.
3. Control limits for sediments prepared by DCM extraction.
4. SQC-1238 (Sediment) is the CRM used for sediments. Use of this SRM began in August 2010. Control charts were generated from that time up to April 2011.
5. DORM-3 (Dogfish Muscle) is the CRM used for most biota samples.

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Table 3 Quality Control Acceptance Criteria and General Analytical Run Sequence for the Initial Demonstration of Capability for the Analysis of Methyl Mercury

Run	Run Name	Section Name	Analyze	Requirements
1 2 3	Rinse Rinse Rinse	Blanking Equipment	DIW + analytical reagents	n/a
4 5 6	IBL IBL IBL	Calibration	Ethylation Blank Ethylation Blank Ethylation Blank	≤ the MRL
7 8 9 10 11 12 13	0.5 pg std 1 pg std 2 pg std 10 pg std 50 pg std 250 pg std 1000 pg std	Calibration[1]	0.5 pg std 1 pg std 2 pg std 10 pg std 50 pg std 250 pg std 1000 pg std	RSD of Avg. CF ≤ 15% Recovery of Low Standard 65-135%
14	ICV	Independent Calibration Verification	~30 pg	Recovery 80-120%
15 16	Ethylation Blank Ethylation Blank	Contamination Check	Ethylation Blank Ethylation Blank	≤ the MRL
17	CCV std (25pg)	Continuing Calibration Verification	25 pg	Recovery 67-133%
18 19 20 21	Ethylation Blank Ethylation Blank Ethylation Blank Ethylation Blank	Contamination Check	Ethylation Blank Ethylation Blank Ethylation Blank Ethylation Blank Ethylation Blank Ethylation Blank	≤ the MRL
22 23 24 25 26 27 28	MDL sample MDL sample MDL sample MDL sample MDL sample MDL sample MDL sample	Method Detection Limit[2,3]	Appropriate matrix spiked at a level of 1 – 5 times the expected MDL	Calculated MDL no greater than 5 times the spike level
29	CCV std (25pg)	Continuing Calibration Verification	25 pg	Recovery 67-133%
30	Ethylation Blank	Contamination Check	Ethylation Blank	≤ the MRL
31 32 33 34	IPR std IPR std IPR std IPR std	Initial Precision and Recovery	ICV solution	Ave. recovery 69-131%, RSD ≤ 31%
35	CCV std (25pg)	Continuing Calibration Verification	25 pg	Recovery 67-133%
36	Ethylation Blank	Contamination Check	Ethylation Blank	≤ the MRL

NOTES:
1. All standards and samples are corrected for mean ethylation blank. Lower calibrations can be achieved as long as ethylation blank criteria are still met.
2. All samples are corrected for mean method blank.
3. Distilled samples are recovery corrected prior to calculating the MDL.

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Table 4 Quality Control Acceptance Criteria and General Analytical Run Sequence for the Analysis of Methyl Mercury

RUN	Analyze	Description	Requirements
1 2 3	Rinse Rinse Rinse	DIW + analytical reagents	n/a
4 5 6	IBL IBL IBL	Contamination Check	≤ the MRL
7 8 9 10 11 12 13	0.5 pg std 1 pg std 2 pg std 10 pg std 50 pg std 250 pg std 1000 pg std	Calibration Curve[1]	RSD of Avg. CF ≤ 15% Recovery of Low Standard 65-135%
14	ICV (independent calib. verific.) (prepared with NIST 1946; around 30 pg MeHg)	Precision and Recovery	80 – 120% recovery
15 16	Ethylation Blank Ethylation Blank	Contamination Check	≤ the MRL
17	CCV std (25 pg)	Continuing Calibration Check	67 – 133% recovery
18 19 20 21	Ethylation Blank Ethylation Blank Ethylation Blank Ethylation Blank	Contamination Check	≤ the MRL
22 23 24 25	Method Blank 1 (MB-1) Method Blank 2 (MB-2) Method Blank 3 (MB-3) Method Blank 4 (MB-4)	Contamination Check	Refer to specific water and solid criteria found in Tables 5 and 6.
Next	Known Blanks	Trip, Field, or Equipment Blanks	Result < ML or < 1/5th associated sample results
Next	BS or CRM	Precision and Recovery	Rec = 70 – 130%[3] for aqueous, Rec = 65 – 135% for sediment samples, and Rec = 65-135% for biota samples
Next	Sample 01[2] Sample 01MD	Native Sample Duplicate Sample	RPD ≤ 35% or ±MRL for aqueous samples and ±2xMRL for solids if results are ≤5xMRL
Next	Sample 01MS Sample 01MSD	Matrix Spike Matrix Spike Duplicate	Rec = 65 – 135%[3] for aqueous; Rec = 65 – 135% for sediment and biota samples; RPD ≤ 35%
Next	Sample 02 through Sample 10	Client Sample	
Next	CCV std (25 pg)	Continuing Calibration Check	67 – 133% recovery
Next	Ethylation Blank	Contamination Check	≤ the MRL
Next	Sample 11MS Sample 11MSD	Matrix Spike Matrix Spike Duplicate	Rec = 65 – 135%[3] for aqueous; Rec = 65 – 135% for sediment and biota samples; RPD ≤ 35%
Next	Sample 12 through Sample 20	Client Sample	
Last	CCV std (25 pg)	Continuing Calibration Check	67 – 133% recovery
Next	Ethylation Blank	Contamination Check	≤ the MRL

NOTES:

1. The calibration curve may be adjusted depending on the expected range of samples (i.e. seds and biota 10pg-5000pg). Lower calibrations can be achieved as long as ethylation blank criteria are still met.
2. Any known field or equipment blanks should not be spiked and should be analyzed prior to other samples. The acceptance criterion for these samples is a result < the ML.
3. Recovery corrected.

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Table 5 Quality Control Acceptance Criteria and Corrective Action Guidelines for the Analysis of Methyl Mercury in Aqueous Samples by Distillation or Direct Ethylation

QC Sample	Measure	Minimum Frequency	Criteria	Corrective Action
Ethylation Blank	Contamination from bubblers	4 prior to calib.; following calib. and end of batch	≤ the MRL	Clean and test bubblers until criteria met prior to any analysis
Calibration Standards	Acceptability of the Calibration Curve	Daily, prior to analysis of samples or whenever the CCV fails	RSD of response factors ≤ 15%; Recovery of Low Standard = 65 – 135%	Reanalyze suspect calibration standard. If criteria still not met, then remake standards and recalibrate the instrument
Independent Calib. Ver. (ICV) Continuing Calib. Ver. (CCV)	Accuracy	Following Cal.; Beginning and end and 1 per 10 sample preparations	ICV Rec. = 80-120% CCV Rec. = 67-133%	Correct problem (recalibrate, remake standard, etc.) and reanalyze ICV/CCV. If criteria met, reanalyze samples backwards (if possible) until 2 consecutive results with RPD ≤ 20%
Carryover Check Ethylation Blank	Contamination due to carryover in the bubbler/trap	Following any unusually high result and CCV. Currently ≥ 2x the high standard	≤ the MRL	Clean and continue to test bubbler/trap combo until criteria met prior to further use. Reanalyze samples that were analyzed in same bubbler/trap following high result
Method Blank	Contamination from reagents, lab ware, etc.	4 per batch	Avg ≤ 0.045 ng/L StDev ≤ 0.015 ng/L or < 1/10th of associated samples	Correct problem. All samples associated with a contaminated method blank must be reanalyzed.
Blank Spike (BS)	Accuracy	1 per 20 samples	Recovery = 70 – 130%*; RPD ≤ 30%	Reanalyze remaining volume. Correct problem prior to continuing analysis
Matrix Spike/Spike Duplicate	Accuracy and Precision within a given matrix	1 per 10 client samples	Recovery = 65 – 135%*; RPD ≤ 35%	If **recoveries** similar but fail recovery criteria, an interference is present in the sample and the result must be qualified. If **RPD** criteria not met, then the system is not in control. Correct problem and reanalyze all associated samples.
Method Duplicates	Precision	Per client request	RPD ≤ 35% or ± MRL if sample < 5x MRL	Correct problem and reanalyze all associated samples.
Surrogate Spike	Efficiency	Every sample analyzed via direct ethylation	Recovery 70-130%	Reanalyze at the same or less volume; do perform an MS on the sample.

* Recovery Criteria for Matrix Spikes and BS samples are based on recovery corrected results.

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Table 6 Quality Control Acceptance Criteria and Corrective Action Guidelines for the Analysis of Methyl Mercury in Solid Samples by Distillation, Extraction, and/or Digestion

QC Sample	Measure	Minimum Frequency	Criteria	Corrective Action
Ethylation Blank	Contamination from bubblers	4 prior to calib.; following calib. and end of batch	≤ the MRL	Clean and test bubblers until criteria met prior to any analysis
Calibration Standards	Acceptability of the Calibration Curve	Daily, prior to analysis of samples or whenever the CCV fails	RSD of response factors ≤ 15%; Recovery of Low Standard = 65 – 135%	Reanalyze suspect calibration standard. If criteria still not met, then remake standards and recalibrate the instrument
Independent Calib. Ver. (ICV) Continuing Calib. Ver. (CCV)	Accuracy	Following Cal.; Beginning and end and 1 per 10 sample preparations	ICV Rec. = 80-120% CCV Rec. = 67-133%	Correct problem (recalibrate, remake standard, etc.) and reanalyze ICV/CCV. If criteria met, reanalyze samples backwards (if possible) until 2 consecutive results with RPD ≤ 20%
Carryover Check Ethylation Blank	Contamination due to carryover in the bubbler/trap	Following any unusually high result. Currently ≥ 2x the high standard	≤ the MRL before further analysis of samples on same bubbler/trap	Clean and continue to test bubbler/trap combo until criteria met prior to further use. Reanalyze samples that were analyzed in same bubbler/trap following high result
Method Blank	Contamination from reagents, lab ware, etc.	4 per batch	Avg ≤ 2 x MDL StD ≤ 2/3rd MDL or < 1/10th of associated samples	Correct problem. All samples associated with a contaminated method blank must be reanalyzed.
Certified Reference Material (CRM)	Accuracy	1 per 20 samples	Soil Rec=65-135% Biota Rec=65-135%*	Correct problem prior to continuing analysis
Matrix Spike/Spike Duplicate	Accuracy and Precision within a given matrix	1 per 10 client samples	Soil Rec=65-135%; RPD ≤ 35% Biota Rec=65-135%*; RPD ≤ 35%	If **recoveries** similar but fail recovery criteria, an interference is present in the sample and the result must be qualified. If **RPD** criteria not met, then the system is not in control. Correct problem and reanalyze all associated samples.
Method Duplicate	Precision within a given matrix	In association with MS/MSD	RPD ≤ 35% or ± 2x MRL if sample < 5x MRL	If **RPD** criteria not met, then the system is not in control. Correct problem and reanalyze all associated samples.
Surrogate Spike**	Efficiency	Every sample analyzed via direct ethylation	If recovery 50-150%, then sample results are corrected for the surrogate recovery.	Reanalyze at the same or less volume; perform an MS on the sample.

* Recovery Criteria for Distilled Matrix Spikes and CRM samples are based on recovery corrected results.
** If surrogate spikes are performed, then the following criteria is applied.

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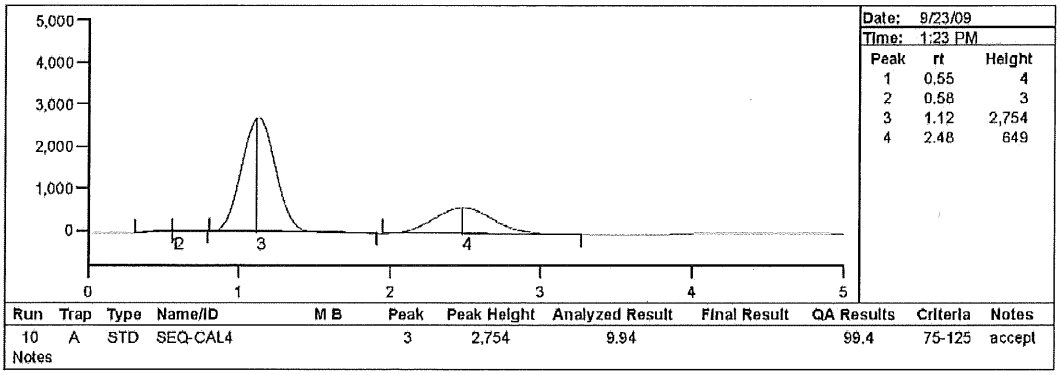
Peak Report

Batch Number: B091247
Method Number: BR-0011

Project Number(s): 0900780
Instrument ID: BR-11

Date Analyzed: 9/23/09
Analyst Name: MSU

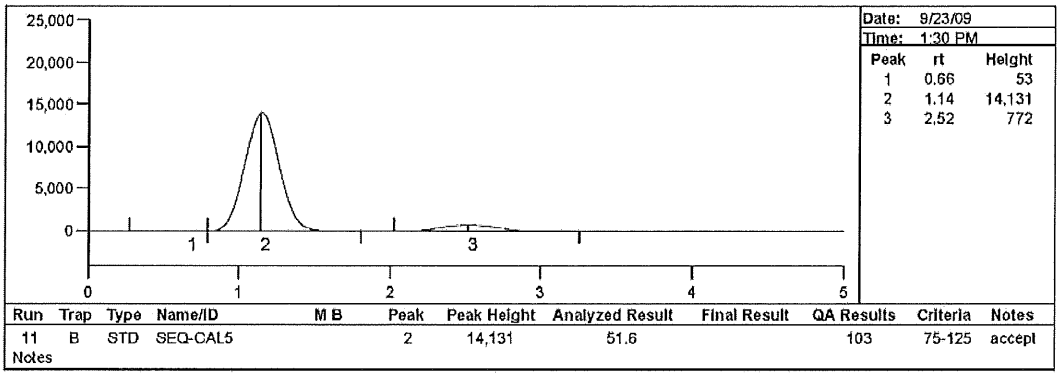


Date: 9/23/09
Time: 1:23 PM

Peak	rt	Height
1	0.55	4
2	0.58	3
3	1.12	2,754
4	2.48	649

Run	Trap	Type	Name/ID	M B	Peak	Peak Height	Analyzed Result	Final Result	QA Results	Criteria	Notes
10	A	STD	SEQ-CAL4		3	2,754	9.94		99.4	75-125	accept

Notes

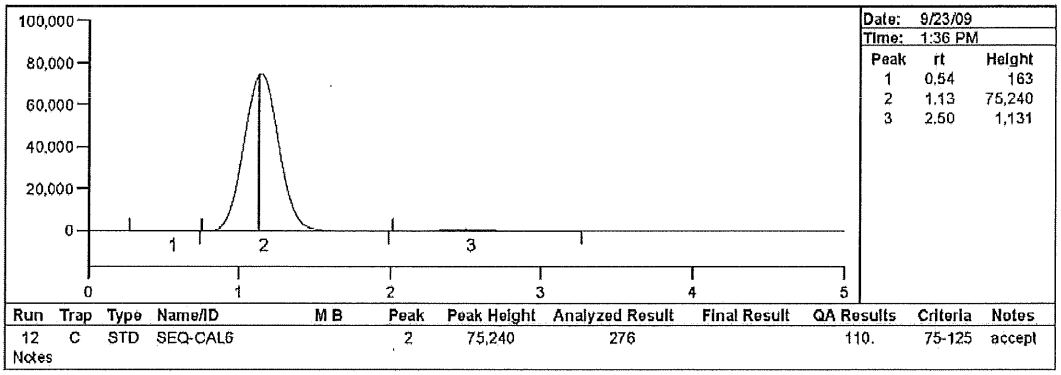


Date: 9/23/09
Time: 1:30 PM

Peak	rt	Height
1	0.66	53
2	1.14	14,131
3	2.52	772

Run	Trap	Type	Name/ID	M B	Peak	Peak Height	Analyzed Result	Final Result	QA Results	Criteria	Notes
11	B	STD	SEQ-CAL5		2	14,131	51.6		103	75-125	accept

Notes



Date: 9/23/09
Time: 1:36 PM

Peak	rt	Height
1	0.54	163
2	1.13	75,240
3	2.50	1,131

Run	Trap	Type	Name/ID	M B	Peak	Peak Height	Analyzed Result	Final Result	QA Results	Criteria	Notes
12	C	STD	SEQ-CAL6		2	75,240	276		110.	75-125	accept

Notes

Page 4 of 25 (Peak Report)

Mercury Guru ver 4.0 © 1995-2008 Brooks Rand LLC

Figure 3 Examples of Typical Chromatograms Generated by the Mercury Guru Software During the Analysis of Methyl Mercury Using EPA Method 1630

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Example Log

Brooks Rand Labs

MMHg Water Prep Benchsheet

Prepped By: ____ SOP/Rev #: BR-0011 / _____

Prep Date: ____ Batch: ____

Sample ID	Sample Mass (g)	Slot #	Time On	Time Off	pH	Sample ID	Sample Mass (g)	Slot #	Time On	Time Off	pH

Batch QC ID	Source	Spike vol (uL)	Spike conc (ng/mL)	Spike ID	Spike Witness	Reagent	ID
						0.5 mL H2SO4	
						0.2 mL KCL/ L-cysteine	
						HCl	
						Hot Block Temp	
						Final Dilution Vol	
Comments:						Balance ID	

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Example Log

Brooks Rand Labs

MMHg Biota Prep Benchsheet

SOP/Rev BR-0011 Rev ____

Prepped By: Batch: ____

Preparation Start Date/Time*:

* Time is when the first reagents are added.

Preparation End Date/Time**:

** Time is when the last sample is brought upto volume

Sample ID	Sample Mass (g)	Sample ID	Sample Mass (g)	Sample ID	Sample Mass (g)

Batch QC ID	Sample Source	Spike vol (uL)	Spike conc (ng/mL)	Spike/CRM ID	Spike Wit-ness

Target Temp/Time:	65 C/4 hours
Oven ID:	
Oven Temp (measured / corrected):	/
time on:	
time off:	
Balance ID:	
Thermometer ID:	
Volume:	

Reagent	ID
1 mL KOH/Me	
Methanol	

Comments:

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Example Log

Brooks Rand Labs

MMHg Sed/Soil Prep Benchsheet SOP / Revision #: BR-0011 Rev_____

Prepped By: _____ **Batch:** _____

Preparation Start Date/Time*: _____ Preparation End Date/Time**: _____

* Time is when the first reagents are added.

** Time is when the last sample is brought upto volume

Sample ID	Sample mass (g)	Original vial (g)	vial plus DCM (g)	EXINFO 1 EXTRACT. DCM (g)	EXINFO 2 Empty Bottle (g)	EXINFO 3 Bottle + DCM (g)	Recovered DCM (for LIMS calcs)	Rec. DCM/ext. DCM
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!
				0.000			0.000	#DIV/0!

Batch QC ID	Sample Source	Spike vol (uL)	Spike conc (ng/mL)	Spike/CRM ID	Spike Witness
BS1		63	1.0		
MS/MSD1					
MS/MSD2					
MS/MSD3					
SRM1/2	SQC-1238				

	Reagent ID
CuSO4	
KBr/H2SO4	
DCM	
Balance ID:	
Thermometer ID:	
(measured / corrected):	/
Date/Time On:	
Date/Time Off:	
Final Dilution Vol:	

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(Example Log) **MeHg-Autoanalyzer Analysis Sheet** Page 1 of ____

Sequence:_____ Batch:_____ Analyst:_____

Instrument ID#:_____ Standards:1 ng/mL:_____ 0.01 ng/mL:_____

Date:_____ Buffer:_____ $NaBEt_4$:_____

ICV:_____

	Run/ Vial Position	Sample ID	Analyzed volume (mL)	Dilution Factor	Comments **$NaBEt_4$ ID and time out**
	1	Rinse	---		
	2	Rinse	---		
	3	Rinse	---		
	4	SEQ-IBL1	---		
	5	SEQ-IBL2	---		
	6	SEQ-IBL3	---		
	7	SEQ-CAL1	0.050		0.01 ng/mL
	8	SEQ-CAL2	0.100		0.01 ng/mL
	9	SEQ-CAL 3	0.200		0.01 ng/mL
	10	SEQ-CAL 4	1.00		0.01 ng/mL
	11	SEQ-CAL 5	0.050		1.0 ng/mL
	12	SEQ-CAL 6	0.250		1.0 ng/mL
	13	SEQ-CAL 7	1.00		1.0 ng/mL
	14	SEQ-ICV1	0.025		1.0 ng/mL second source
	15	SEQ-CCB1	---		
	16	SEQ-CCB2	---		
	17	SEQ-CCV1	0.025		1.0 ng/mL
	18	SEQ-CCB3	---		
	19	SEQ-CCB4	---		
	20	SEQ-CCB5	---		
	21	SEQ-CCB6	---		

Comments:_____

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(Example Log) **MeHg Analysis Sheet** Page ____ of ____

Sequence:_____ Analyst:_____ Date:_____

	Run/ Vial Position	Sample ID	Analyzed volume (mL)	Dilution Factor	Comments **$NaBEt_4$ ID and time out**

Comments:_____

_____

All Brooks Rand Labs (BRL) SOPs are Proprietary Information and protected by WA state law. Proprietary Information shall be kept in the strictest confidence & shall not be used or appropriated to benefit any party without prior written consent from BRL.

Appendix A: Brooks Rand Labs' Procedure for EPA Draft Method 1630 (01/01)

Differences Between EPA Method 1630 and Brooks Rand Labs SOP #BR-0011

The following differences exist between EPA Method 1630 (with relevant sections marked in boldface) and the practices employed by Brooks Rand Labs (SOP #BR-0011):

- **Section 1.1** of EPA Draft Method 1630 (hitherto referred to as simply 1630) states that the scope of the method is for the determination of methyl mercury in aqueous samples. Brooks Rand Labs has made use of several peer reviewed papers to expand the scope of the method to include sediment and biota. Therefore, any description of the preparation or analysis of sediment or biota samples found in this SOP will NOT be found in 1630 and should be considered a difference.

- According to 1630, Carbotraps® are heated for 45 seconds at a temperature of 450-500 °C (**Section 6.5.4**). Brooks Rand Labs uses Tenax traps instead of Carbotraps®. The Tenax traps are heated for 30 seconds at a temperature of 200 °C.

- 1630 describes the GC column as being 1 meter long (**Section 6.5.6.1**); whereas, the GC column used at Brooks Rand Labs is 50 cm long.

- **Section 6.5.6.4** of 1630 states that the GC column should be heated to a temperature of 110 °C (± 2 °C). At Brooks Rand Labs the GC column is set at a temperature of 90-105 °C.

- **Section 7.8** of 1630 states that frozen ethylation reagent ($NaBEt_4$) is good for one week. Brooks Rand Labs has found frozen $NaBEt_4$ to be stable for up to one month as long as it has not been thawed.

- **Sections 9.4.1, 10.1.1.2, 11.2.1, and 11.2.2** of 1630 state that the bubblers with ethylation blanks, standards, and samples should have 300 µL of acetate buffer and 40 µL of $NaBEt_4$ added to them prior to purging. Brooks Rand Labs adds the 300 µL of acetate buffer, but adds 50 µL of $NaBEt_4$.

- The calibration standards used in 1630 are listed, in order of analysis, as 5 pg, 50 pg, 100 pg, 200 pg, and 1000 pg (**Section 10.1.1.2**). Brooks Rand Labs calibrates the instrument using the following standards: 2 pg, 10 pg, 50 pg, 250 pg, and 1000 pg.

- **Section 11.1.1** of 1630 makes no mention of adding additional H_2SO_4 to the sample prior to distillation. Brooks Rand Labs routinely adds 0.5 mL of 9M H_2SO_4 to each distillation vial prior to beginning the distillation.

- **Section 11.1.1** of 1630 states that 200 µL of [redacted] APDC solution is used as the chelator and is added to the distillation vial just prior to beginning the distillation. Brooks Rand Labs uses a

All Brooks Rand Labs (BRL) SOPs are Proprietary Information and protected by WA state law. Proprietary Information shall be kept in the strictest confidence & shall not be used or appropriated to benefit any party without prior written consent from BRL.

[redacted] KCl / [redacted] L-Cysteine solution as the chelator and adds 200 µL of this solution to the distillation vial.

- 1630 states that once the sample preparation and all of the reagents have been added to the reaction vessel (bubbler), they should be allowed to react for 17 minutes so that all of the methyl mercury is converted to volatile methylethyl mercury prior to purging (**Sections 10.1.1.2 and 11.2.4**). Brooks Rand Labs has found that 15 minutes are sufficient for this process.

- 1630 states that the bubbler contents should be purged onto the trap for 17 minutes (**Section 11.2.5**). Brooks Rand Labs has found that 15 minutes are sufficient for this process.

- Following purging, 1630 states that any adsorbed water should be removed from the Carbotraps® by drying the trap for 7 minutes with N_2 gas (**Section 11.2.6**). Brooks Rand Labs has found that 5 minutes is sufficient for drying the Tenax traps.

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Appendix B: Manual MeHg Analysis

INSTRUMENT CALIBRATION AND SAMPLE ANALYSIS

Instrument Calibration: BRL follows EPA method 1630, Section 10.0 for the instrument calibration with the same exceptions as for sample analysis. Standards, typically 2, 10, 50, 250, and 1000 pg MeHg are added into reaction vessels containing 50-75 mL of DIW and 300 µL of 2M acetate buffer.

Instrumental Analysis: BRL has adopted the following modifications.

For samples, add appropriate sample volumes plus DIW as necessary for a final bubbler volume of 50 mL to 75 mL (for sample preparation see Section 7 of this SOP). Some acid can be carried over during distillation causing some distillates may have low pH (< 4). In that event, [redacted] acetate buffer should be added to bring the final pH to [redacted], which is the optimum pH for ethylation. An aliquot of [redacted] $NaBEt_4$ is added, the 4-way valve-cap inserted and clamped, and the vessel swirled to wash any droplets back into solution. Allow the mixture to react without purging [redacted].

Place a trapping column on the bubbler with the kinked side toward the bubbler. It is best to load the kinked side then reverse the flow into the GC column so the trapped species do not have to flow all the way through the Tenax trap. The bubbler is then purged with N_2 at a flow rate of [redacted]. The organomercury compounds are swept from solution and collected onto the trapping column. Then the trap is taken off and hooked directly to the gas-line for [redacted] minutes, to remove water condensation from the trap. Afterwards, connect the trapping column in-line with the GC column with the kinked side toward the GC.

When using a Tenax trap, special attention must be paid to the orientation of the trap. The trap is placed so that the end facing the bubbler output is now facing the GC column input to avoid the organomercury species passing through the entire length of the heating trap column and decomposing to Hg(0) (Liang, Bloom, and Bloom 1994). Under a argon flow rate of [redacted], apply appropriate voltage to the coil around the column so that the column reaches [redacted] from room temperature within 30 seconds. Peak integration is begun in conjunction with the heating of the trap. The organomercury species are desorbed and carried through the GC column that is held in an oven at [redacted]. The species elute in order of increasing molecular weight, pass through the pyrolitic column, held at approximately [redacted] at which point all organomercury species are converted into Hg(0), and detected by CVAFS. The sparging/reaction vessels must be triple rinsed with DIW after each use to flush out reaction by-products that can interfere with subsequent purgings.

All Brooks Rand Labs (BRL) SOPs are Proprietary Information and protected by WA state law. Proprietary Information shall be kept in the strictest confidence & shall not be used or appropriated to benefit any party without prior written consent from BRL.

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/ACLASS
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Brooks Rand Labs, LLC
3958 6th Ave. NW
Seattle, WA 98107

has been assessed by ACLASS
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field(s) of

TESTING

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of tests to which this accreditation applies.

ADE-1447
Certificate Number

ACLASS Approval

Certificate Valid: 03/30/2012-03/30/2014
Version No. 002 Issued: 04/09/2012

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated January 2009*).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 & DoD-ELAP

Brooks Rand Labs, LLC
3958 6th Ave NW, Seattle, WA 98107
Frank McFarland Phone: 206-632-6206

TESTING

Valid to: March 30, 2014 Certificate Number: ADE- 1447

I. Environmental

MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water Solids Biological Tissue	Elemental Analysis	1638 modified 200.8 modified 6020 modified	ICP-MS
Seawater	Elemental Analysis	1640 modified BR-0060	ICP-MS
Water	Se speciation	BR-0061	HPLC-ICP-MS
Water Biological Tissue	As speciation	1632A	HGAAS
Solids	As speciation	1632A modified	HGAAS
Water	Hg	1631E	CVAFS
Solids Biological Tissue	Hg	1631E (appendix)	CVAFS
Water	Methyl Mercury	1630	CVAFS
Solids Biological Tissue	Methyl Mercury	1630 modified	CVAFS
Water	Hardness – total (as $CaCO_3$)	SM 2340 B (20th Ed.) By calculation of : 1638 modified 200.8 modified 6020 modified	ICP-MS (calc.)

MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Total Suspended Solids	SM 2540 D (20th Ed.)	Gravimetric
Solids	Dry weight	SM 2540 E (20th Ed.)	Gravimetric

Notes:

1. ** = As Applicable*
2. *** = Refer to Accredited Analyte Listing for specific analytes in which the laboratory is accredited.*
3. *This scope is part of and must be included with the Certificate of Accreditation No. ADE- 1447*

Vice President

500 Montgomery St. Suite 625 | Alexandria, VA 22314 | 703-836-0025 | www.aclasscorp.com

Accredited Analytes/Methods (by matrix)

Brooks Rand Labs, LLC

Seattle, WA

Analyte	Matrix										
	Aqueous			Solids			Biological Tissue			Seawater	
Metals											
Aluminum	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Antimony	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Arsenic	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Barium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Beryllium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Boron	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Cadmium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Calcium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Chromium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Cobalt	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Copper	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Iron	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Lead	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Magnesium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Manganese	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Mercury	EPA 1631E			EPA 1631E			EPA 1631E				
Mercury (Low-Level)	EPA 1631E										
Molybdenum	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Nickel	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Selenium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Silver	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Sodium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)					
Strontium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Thallium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Tin	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Titanium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)		
Uranium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)								
Vanadium	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Zinc	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)	EPA 1640 (Modified)	BR-0060
Misc Analytes											
Total Hardness (as CaCO3)	EPA 1638 (Modified)	EPA 200.8 (Modified)	EPA 6020 (Modified)								

Accredited Analytes/Methods (by matrix)

Brooks Rand Labs, LLC

Seattle, WA

Analyte	Matrix										
	Aqueous			Solids			Biological Tissue			Seawater	
Non-Filterable Residue (TSS)	2540D										
Residue-total (total solids)				2540E							
Methyl Mercury	EPA 1630			EPA 1630 (Modified)			EPA 1630 (Modified)				
Arsenic Speciation	EPA 1632 A			EPA 1632 A (Modified)			EPA 1632A				
Selenium Speciation	BR-0061										

State of Florida
Department of Health, Bureau of Public Health Laboratories

This is to certify that

E87982

BROOKS RAND LLC
3958 SIXTH AVE. NW
SEATTLE, WA 98107

has complied with Florida Administrative Code 64E-1,
for the examination of environmental samples in the following categories

NON-POTABLE WATER - METALS, SOLID AND CHEMICAL MATERIALS - METALS, BIOLOGICAL TISSUE - METALS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Public Health Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

Date Issued: October 05, 2012 Expiration Date: June 30, 2013

Victor Johnson
Interim Director, Division of Emergency Preparedness and Community Support
Florida Department of Health
DH Form 1697, 7/04
NON-TRANSFERABLE E87982-18-10/05/2012
Supersedes all previously issued certificates

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87982 **EPA Lab Code:** WA00252 **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Aluminum	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Aluminum	EPA 200.8	Metals	NELAP	9/24/2012
Aluminum	EPA 6020	Metals	NELAP	9/24/2012
Antimony	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Antimony	EPA 1638	Metals	NELAP	7/16/2008
Antimony	EPA 200.8	Metals	NELAP	9/24/2012
Antimony	EPA 6020	Metals	NELAP	9/24/2012
Arsenic	BR-0020 Revision 008/HGAAS	Metals	NELAP	11/16/2009
Arsenic	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Arsenic	EPA 1632	Metals	NELAP	11/16/2009
Arsenic	EPA 1640	Metals	NELAP	9/24/2012
Arsenic	EPA 200.8	Metals	NELAP	9/24/2012
Arsenic	EPA 6020	Metals	NELAP	9/24/2012
Arsenic-III (arsenite)	EPA 1632	Metals	NELAP	9/24/2012
Barium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Barium	EPA 200.8	Metals	NELAP	9/24/2012
Barium	EPA 6020	Metals	NELAP	9/24/2012
Beryllium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Beryllium	EPA 200.8	Metals	NELAP	9/24/2012
Beryllium	EPA 6020	Metals	NELAP	9/24/2012
Bismuth	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Boron	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Cadmium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Cadmium	EPA 1638	Metals	NELAP	7/16/2008
Cadmium	EPA 1640	Metals	NELAP	11/16/2009
Cadmium	EPA 200.8	Metals	NELAP	9/24/2012
Cadmium	EPA 6020	Metals	NELAP	9/24/2012
Calcium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Calcium	EPA 6020	Metals	NELAP	9/24/2012
Chromium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Chromium	EPA 200.8	Metals	NELAP	9/24/2012

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87982 **EPA Lab Code:** WA00252 **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Chromium	EPA 6020	Metals	NELAP	9/24/2012
Cobalt	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Cobalt	EPA 200.8	Metals	NELAP	9/24/2012
Cobalt	EPA 6020	Metals	NELAP	9/24/2012
Copper	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Copper	EPA 1638	Metals	NELAP	7/31/2006
Copper	EPA 1640	Metals	NELAP	11/16/2009
Copper	EPA 200.8	Metals	NELAP	9/24/2012
Copper	EPA 6020	Metals	NELAP	9/24/2012
Dimethylarsinate	EPA 1632	Metals	NELAP	9/24/2012
Hardness	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Iron	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Iron	EPA 6020	Metals	NELAP	9/24/2012
Lead	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Lead	EPA 1638	Metals	NELAP	7/31/2006
Lead	EPA 1640	Metals	NELAP	11/16/2009
Lead	EPA 200.8	Metals	NELAP	9/24/2012
Lead	EPA 6020	Metals	NELAP	9/24/2012
Lithium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Magnesium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Magnesium	EPA 6020	Metals	NELAP	9/24/2012
Manganese	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Manganese	EPA 200.8	Metals	NELAP	9/24/2012
Manganese	EPA 6020	Metals	NELAP	9/24/2012
Mercury	EPA 1631	Metals	NELAP	7/31/2006
Methyl mercury	BR-0011 Revision 013/CVAFS	Metals	NELAP	11/16/2009
Methyl mercury	EPA 1630	Metals	NELAP	7/31/2006
Molybdenum	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Molybdenum	EPA 200.8	Metals	NELAP	9/24/2012
Molybdenum	EPA 6020	Metals	NELAP	9/24/2012
Monomethylarsonate	EPA 1632	Metals	NELAP	9/24/2012

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87982 **EPA Lab Code:** WA00252 **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Nickel	BR-0060 Revision 003/ICP-MS	Metals	NELAP	11/16/2009
Nickel	EPA 1638	Metals	NELAP	11/16/2009
Nickel	EPA 1640	Metals	NELAP	11/16/2009
Nickel	EPA 200.8	Metals	NELAP	9/24/2012
Nickel	EPA 6020	Metals	NELAP	9/24/2012
Potassium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Potassium	EPA 6020	Metals	NELAP	9/24/2012
Selenium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Selenium	EPA 1638	Metals	NELAP	7/31/2006
Selenium	EPA 200.8	Metals	NELAP	9/24/2012
Selenium	EPA 6020	Metals	NELAP	9/24/2012
Selenium (IV)	BR-0061 Revision 000/HPLC-ICP-MS	Metals	NELAP	11/16/2009
Selenium (VI)	BR-0061 Revision 000/HPLC-ICP-MS	Metals	NELAP	11/16/2009
Silver	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Silver	EPA 1638	Metals	NELAP	7/31/2006
Silver	EPA 1640	Metals	NELAP	9/24/2012
Silver	EPA 200.8	Metals	NELAP	9/24/2012
Silver	EPA 6020	Metals	NELAP	9/24/2012
Sodium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Sodium	EPA 6020	Metals	NELAP	9/24/2012
Strontium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Thallium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Thallium	EPA 1638	Metals	NELAP	7/31/2006
Thallium	EPA 200.8	Metals	NELAP	9/24/2012
Thallium	EPA 6020	Metals	NELAP	9/24/2012
Tin	BR-0060 Revision 003/ICP-MS	Metals	NELAP	11/16/2009
Titanium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Tungsten	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Uranium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/24/2012
Uranium	EPA 200.8	Metals	NELAP	9/24/2012

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87982 **EPA Lab Code:** WA00252 (206) 632-6206

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Uranium	EPA 6020	Metals	NELAP	9/24/2012
Vanadium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Vanadium	EPA 200.8	Metals	NELAP	9/24/2012
Vanadium	EPA 6020	Metals	NELAP	9/24/2012
Zinc	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Zinc	EPA 1638	Metals	NELAP	7/31/2006
Zinc	EPA 1640	Metals	NELAP	9/24/2012
Zinc	EPA 200.8	Metals	NELAP	9/24/2012
Zinc	EPA 6020	Metals	NELAP	9/24/2012

Laboratory Scope of Accreditation

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State Laboratory ID: E87982 **EPA Lab Code:** WA00252 **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: **Solid and Chemical Materials**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Antimony	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Arsenic	BR-0020 Revision 008/HGAAS	Metals	NELAP	6/27/2011
Arsenic	BR-0021 Revision 004/HGAAS	Metals	NELAP	6/27/2011
Arsenic	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Beryllium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Cadmium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Chromium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Cobalt	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Copper	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Lead	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Mercury	BR-0002 Revision 10/CVAFS	Metals	NELAP	7/16/2008
Mercury	EPA 1631	Metals	NELAP	7/31/2006
Methyl mercury	BR-0011 Revision 013/CVAFS	Metals	NELAP	11/16/2009
Molybdenum	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Nickel	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Selenium	BR-0020 Revision 008/HGAAS	Metals	NELAP	9/26/2011
Selenium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Silver	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Strontium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Thallium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Zinc	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: **E87982** **EPA Lab Code:** **WA00252** **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: **Biological Tissue**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Aluminum	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Antimony	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Arsenic	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Arsenic	EPA 1632	Metals	NELAP	6/27/2011
Arsenic-III (arsenite)	EPA 1632	Metals	NELAP	9/24/2012
Barium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Beryllium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Boron	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Cadmium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Calcium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Chromium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Cobalt	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Copper	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Dimethylarsinate	EPA 1632	Metals	NELAP	9/24/2012
Iron	BR-0060 Revision 003/ICP-MS	Metals	NELAP	6/27/2011
Lead	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Magnesium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	9/26/2011
Manganese	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Mercury	BR-0002 Revision 10/CVAFS	Metals	NELAP	7/16/2008
Mercury	EPA 1631	Metals	NELAP	7/31/2006
Methyl mercury	BR-0011 Revision 013/CVAFS	Metals	NELAP	11/16/2009
Molybdenum	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Monomethylarsonate	EPA 1632	Metals	NELAP	9/24/2012
Nickel	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Selenium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Silver	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008

Laboratory Scope of Accreditation

Attachment to Certificate #: E87982-18, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: **E87982** **EPA Lab Code:** **WA00252** **(206) 632-6206**

E87982
Brooks Rand LLC
3958 Sixth Ave. NW
Seattle, WA 98107

Matrix: **Biological Tissue**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Thallium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Titanium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Vanadium	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008
Zinc	BR-0060 Revision 003/ICP-MS	Metals	NELAP	7/16/2008