FINAL

Fourth Five-Year Review
Fort Riley, Kansas

Prepared for:

Headquarters, 1st Infantry Division and Fort Riley, Kansas
Department of Army
Headquarters, United States Army Garrison, Fort Riley
Fort Riley, Kansas 66442-7000

And

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Prepared by:

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Louisville District
Louisville, Kentucky

September 2017

U.S. Army Environmental Command
Fort Sam Houston, Texas

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Fourth Five-Year Review Report

Fort Riley, Kansas

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List of Acronyms

AEC	U. S. Army Environmental Command
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
BAI	Bioavailability Ferric Iron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	*cis*-1,2-Dichloroethene
COC	Chemical of Concern
DCF	Dry Cleaning Facilities
DCFA	Dry Cleaning Facilities Area (Operable Unit 003)
DO	Dissolved Oxygen
EM CX	Environmental and Munitions Center of Expertise
ESD	Explanation of Significant Difference
EE/CA	Engineering Evaluation/Cost Analysis
FFA	Federal Facility Agreement
FFTA-MAAF	Former Fire Training Area-Marshall Army Airfield (Operable Unit 004)
FS	Feasibility Study
FYR	Five-Year Review
GC	Gas Chromatograph
HGL	HydroGeologic, Inc.
IAP	Installation Action Plan
IC	Institutional Control
IDW	Investigation Derived Waste
IMCOM	Installation Management Command
IRP	Installation Restoration Program
ISCO	In-Situ Chemical Oxidation
KDHE	Kansas Department of Health and Environment
LTMCP	Long-Term Management and Care Plan
LTM	Long-Term Monitoring
LUC	Land Use Control
LUCIP	Land Use Control Implementation Plan
MEE	Methane, Ethane, and Ethene
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MW	Monitoring Well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Protection Act
NPL	National Priorities List
O&M	Operations and Maintenance
ORP	Oxygen-Reduction Potential
OU	Operable Unit
PAL	Project Action Limit

PA/SI	Preliminary Assessment/Site Inspection
PCE	Perchloroethene or Tetrachloroethene
PDI	Pre-Design Investigation
PRG	Preliminary Remediation Goal
PWE	Directorate of Public Works – Environmental Division
RACR	Response Action Completion Report
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RG	Remediation Goal
ROD	Record of Decision
RPMP	Real Property Master Plan
RSK	Risk-Based Value for Kansas
RSL	Regional Screening Levels
SFL	Southwest Funston Landfill (Operable Unit 001)
SWFL	Southwest Funston Landfill (Operable Unit 001)
TA	Training Area
TBC	To Be Considered
TCE	Trichloroethene
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
UU/UE	Unlimited Use/Unrestricted Exposure
VC	Vinyl Chloride
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level calculator
VOC	Volatile Organic Compound

Executive Summary

The U.S. Army has completed the fourth Five-Year Review (FYR) of remedial actions at Fort Riley near Junction City, Kansas. The purpose of this FYR was to determine whether the remedial actions implemented at the site are protective of human health and the environment.

There are nine (9) Operable Units (OUs) at Fort Riley. This FYR fully evaluated the performance and protectiveness of three OUs:

- **OU 001, Southwest Funston Landfill**
- **OU 003, Dry Cleaning Facilities Area**
- **OU 005, 354 Area Solvent Detections**

The remaining OUs are not addressed because they have achieved an unlimited use/unrestricted exposure (UU/UE) designation (OU 002 and OU 004), a remedy has not been implemented (OU 006 and OU 008), or a remedy has not been selected (OU 007 and OU 009).

Based on the data reviewed, interviews, and site inspections, the remedies at OU 001, OU 003, and OU 005, are currently functioning as intended by their respective Record of Decisions (RODs). No issues were identified during the fourth Fort Riley FYR.

The remedy for OU 001, Southwest Funston Landfill, is protective of human health and the environment. The remedy, which consists of maintaining a landfill cover and Institutional Controls (ICs), remains protective by preventing direct exposure to buried waste; preventing degradation of the underlying groundwater by minimizing migration of potential constituents from waste to groundwater; and preventing exposure to groundwater by enforcement of ICs that prohibit drilling and installation of water wells, or other activities that could damage the integrity of the landfill cover.

The remedy for OU 003, Dry Cleaning Facilities Area, is protective of human health and the environment. The remedy, which consists of monitored natural attenuation (MNA) with ICs, remains protective by monitoring groundwater to ensure that biodegradation continues to effectively reduce concentrations of Chemicals of Concern (COCs) and eventually meets remediation goals; and preventing exposure to groundwater with enforcement of ICs that prohibit drilling and installation of water wells;

The remedy at OU 005, 354 Area Solvent Detections, is expected to be protective of human health and the environment upon completion of the remedy as described in the 2016 ESD. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Fort Riley Kansas		
EPA ID: KS6214020756		
Region: 7	**State:** KS	**City/County:** Junction City, Geary, Clay, and Riley Counties
SITE STATUS		
NPL Status: Final		
Multiple OUs? 3	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: Choose an item. **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Army		
Author name (Federal or State Project Manager): Fort Riley		
Author affiliation: U.S. Army		
Review period: 2 June 2016 – 20 September 2017		
Date of site inspection: 14 November 2016		
Type of review: Statutory		
Review number: 4		
Triggering action date: 20 September 2012		
Due date *(five years after triggering action date)*: 20 September 2017		

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU 001, OU 003, OU 005

Issues and Recommendations Identified in the Five-Year Review: None

Five-Year Review Summary Form (continued)

Protectiveness Statement(s)		
Operable Unit: OU 001, Southwest Funston Landfill	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* NA

Protectiveness Statement:

The remedy for OU 001, Southwest Funston Landfill, is protective of human health and the environment.

The remedy, which consists of maintaining a landfill cover and ICs, remains protective by:

- Preventing direct exposure to buried waste;
- Preventing degradation of the underlying groundwater by minimizing migration of potential constituents from waste to groundwater; and
- Preventing exposure to groundwater by enforcement of ICs that prohibit drilling and installation of water wells, or other activities that could damage the integrity of the landfill cover.

Operable Unit: OU 003, Dry Cleaning Facilities Area	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* NA

Protectiveness Statement:

The remedy for OU 003, Dry Cleaning Facilities Area, is protective of human health and the environment.

The remedy, which consists of MNA with ICs, remains protective by:

- Monitoring groundwater to ensure that biodegradation continues to effectively reduce concentrations of COCs and eventually meets remediation goals; and
- Preventing exposure to groundwater and vapor intrusion with enforcement of ICs that prohibit drilling and installation of water wells, and residential development.

Operable Unit:	Protectiveness Determination:	Addendum Due Date (if applicable):
OU 005, 354 Area Solvent Detections	Will be Protective	NA

Protectiveness Statement:

The remedy at OU 005, 354 Area Solvent Detections, is expected to be protective of human health and the environment upon completion of the remedy as described in the 2016 ESD. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

1.0 Introduction

1.1 Purpose and Scope of the Five-Year Review

This report presents the Five-Year Review (FYR) for Operable Unit (OU) 001, South Funston Landfill, OU 003, Dry Cleaning Facilities Area (DCF or DCFA), and OU 005, 354 Area Solvent Detections, at Fort Riley, Junction City, Kansas. The purpose of a FYR is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Army Corps of Engineers (USACE) has prepared this FYR report for the U.S. Department of Army, Fort Riley, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP, 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii), states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

Fort Riley is located in north-central Kansas, north-northeast of Junction City and west of Manhattan, Kansas (Figure 1-1). The installation occupies approximately 101,733 acres in Clay, Geary, and Riley Counties. Fort Riley is an active U.S. Army facility under the jurisdiction of Installation Management Command (IMCOM) with a primary mission to train forces to meet joint force requirements across the full spectrum of current and future operations.

Pursuant to Section 105 of the CERCLA, Fort Riley was proposed for inclusion on the National Priority List (NPL) on 14 July 1989. Two OUs were combined by the United States Environmental Protection Agency (USEPA) as one site for Hazard Ranking System scoring purposes. The NPL listing became effective 1 October 1990. To ensure that environmental impacts associated with activities at the installation were investigated and remedial action taken, Fort Riley, USEPA, and the

State of Kansas entered into a Federal Facility Agreement (FFA), effective 28 June 1991. The schedule for remedial action at Fort Riley is found in Section XI B of the FFA.

This is the fourth FYR for Fort Riley. The triggering action for the first statutory review was the signature date of the Record of Decision (ROD) for OU 001, Southwest Funston Landfill, dated 6 August 1997. The triggering action for the fourth FYR was completion of the Third FYR, dated 20 September 2012.

There are nine (9) OUs at Fort Riley. This FYR addressed the remedy for waste and groundwater at OU001, and groundwater at OU 003 and OU 005. Summaries of the RODs for OU 001, OU 003, and OU 005, are provided in Appendix A. The remaining OUs and their current status are summarized in Table 1-1.

Table 1-1
Operable Units Not Evaluated in FYR

OU	Name	Year ROD Signed	Reason Not Evaluated in FYR
OU 002	Pesticide Storage Facility	1997	Unlimited Use/Unrestricted Exposure (UU/UE) designation has been achieved for the site
OU 004	Former Fire Training Area-Marshall Airfield	2005	UU/UE designation has been achieved for the site
OU 006	Open Burning/Open Detonation Ground (Range 16)	2016	Implementation of the remedy has not been initiated at the site
OU 007	World War I Incinerator NW Camp Funston	N/A	A remedy has not been selected for the site.
OU 008	Sherman Heights Small Arms Range	2015	Implementation of the remedy has not been initiated at the site
OU 009	Camp Forsyth Landfill Area 2	N/A	A remedy has not been selected for the site.

1.2 Administrative Components of the Five-Year Review

The USACE, Louisville District team initiated the FYR via a kickoff conference call held on 2 June 2016. Members of the Environmental and Munitions Center of Expertise (EM CX), US Army Environmental Command (AEC), and Fort Riley, were present for the kickoff conference call.

The USACE Project Delivery Team includes engineering, geological and environmental professionals from the USACE Louisville District:

Joan Cullen, P.G., Team Leader, Geologist, Team Member	502-315-6344
Rachel Williams, Environmental Engineer, Team Member	502-315-6343
Douglas Buchanan, P.G., Hydrogeologist, Team Member	502-315-6334
Angela Schmidt, Senior Risk Assessor, Team Member	502-315-6313

The fourth FYR consisted of interviews with Army staff and regulatory agencies, review of relevant site documents, and a site inspection conducted 14 December 2016. The following personnel were interviewed for this FYR and accompanied USACE team members Joan Cullen and Rachel Williams on the site inspection of the OUs:

Directorate of Public Works-Environmental Division (PWE) – Dr. Richard Shields, Installation Restoration Program (IRP) Manager (retired), and David Jones, current IRP Manager;

USEPA – Amer Safadi, Remedial Project Manager;

Kansas Department of Health and Environment (KDHE) – Kelly Peterson, Project Manager.

In addition, changes in cleanup levels, toxicity values, and Applicable or Relevant and Appropriate Requirements (ARARs) were also reviewed.

1.3 Community Notification of the Five-Year Review

A Public Notice was published in the Daily Union Newspaper on 1 September 2016 to notify the community of the commencement of the FYR. The notice included a brief description of the sites being reviewed and contact information for any questions that may arise. A second Public Notice will be issued through the Daily Union following finalization of the Five-Year Review Report. This notice will include the location of the information repository where a copy of the report will be available for review. A copy of the 1 September 2016 Public Notice is provided in Appendix B.

2.0 Southwest Funston Landfill, OU 001

2.1 Chronology of Key Events

Table 2-1
Chronology of Key Events at OU 001

Event	Date
Landfill Operations Began	1950s
Landfill Operations Ceased	1981
Landfill Closed	1983
Initial Discovery of Problem/Contamination	April 1984
Remedial Investigation Report/Revised	1993/1994
Engineering Evaluation/Cost Analysis Report for Riverbank Stabilization and Landfill Cover Repairs	July 1993
Action Memorandum	December 1993
Riverbank Stabilization over 1,200 feet	April 1994
Landfill Cover Repair with 160,000 CY of fill placed	1994-1995
Landfill Cover Improvements	1996 - 1997
Proposed Plan	November 1994
Operations and Maintenance Plan approved	March 1996
Record of Decision	6 August 1996
First Five-Year Review	September 2002
USEPA approves request to change groundwater monitoring from semi-annual to annual and to delete analysis for lead	July 2006
Second Five-Year Review	September 2007
Remedial Action Completion Report signed by USEPA	February 2010
USEPA approved reduction in the groundwater monitoring frequency from annual to a five-year schedule to coincide with five-year reviews.	February 2010
Long-Term Management and Care Plan (LTMCP) approved	March 2011
Third Five-Year Review	September 2012

2.2 Background

2.2.1 Introduction

OU 001 is an Installation Restoration Program (IRP) site and is identified in the Fort Riley Installation Action Plan (IAP) as FTRI-003. South Funston Landfill, OU 001, is also referred to by the acronyms "SWFL" or "SFL" in some supporting documents. The site covers approximately 120 acres in the southern portion of Fort Riley, adjacent to the southwest corner of the Camp Funston cantonment area. The limits of the OU 001 extend from the north bank of the Kansas River north to near Well House Road, and east from the pre-1951 flood Kansas River channel to just west of Threemile Creek (Figure 2-1). The area that received waste in trenches is approximately 107 acres. The waste was placed in trenches approximately 16 feet in depth (Figure 2-2).

2.2.2 Physical Characteristics

The topography at OU 001 slopes very gently toward the east-southeast and lies entirely within the 50-year floodplain and alluvial bottomlands of the Kansas River. The landfill area was graded and a continuous soil cover was constructed as part of closure activities in 1983. The area was then seeded with native grasses. Steep slopes exist along the banks of the Kansas River to the south and along Threemile Creek to the east. Groundwater is present at a depth of approximately 20 feet below the ground surface. Bedrock is at a depth of approximately 45 feet. The dominant groundwater flow is to the southeast toward the Kansas River (Figures 2-3 and 2-4).

2.2.3 Land and Resource Use

OU 001 is located adjacent to the Kansas River, and is bounded by vacant land to the west (which has not been used since the 1993 flood), and the Camp Funston cantonment area to the east. Currently, the entire OU 001 is within a zone designated as "Open Space" in the Environmental Overlay of the Fort Riley Real Property Master Plan (RPMP), dated 15 May 2007. Zones designated as "Open Space" include conservation areas, buffer spaces, undeveloped land, utility easements, safety clearances and security areas. Land use at OU 001 is not expected to change.

The groundwater aquifer underlying OU 001 is currently not a drinking water source. The water supply for Fort Riley comes from a well field containing a total of eight wells located approximately four miles to the west. Groundwater is withdrawn from alluvial aquifers that are recharged by the Republican River.

2.2.4 History of Contamination

OU 001 operated from the mid-1950s to 1981, receiving wastes that included typical municipal waste and industrial wastes from various activities at the installation. The landfill was closed in 1983. Some of these industrial wastes were reported to have contained hazardous substances and were identified as potential sources of contamination. The types of wastes reportedly disposed at OU 001 included wastes generated by vehicle and aircraft maintenance shops, print shops, furniture repair shops, painting facilities, oil analysis laboratory, autoclaved biological waste, pesticide/herbicide storage and preparation, laundry and dry cleaning facilities, and wastewater treatment plants. The wastes may also have included metal-laden oils, solvents, inks, paints and heavy metals, and dried wastewater treatment plant sludge. A remedial investigation in 1992 and 1993 confirmed the presence of volatile organic compounds in groundwater with exceedances of the Federal Maximum Contaminant Levels (MCLs) for drinking water. These included vinyl chloride (VC), 1,2-dichloroethane, benzene and 1,1,2-trichloroethane. Two additional Chemicals of Concern (COCs), *cis*-1,3-dichloropropene and 1,1,2,2-Tetrachloroethane did not have MCLs, but exceeded Kansas risk-based action levels (RSKs).

2.2.5 Initial Response

An Engineering Evaluation/Cost Analysis (EE/CA) was performed in 1993 to assess the appropriateness of performing non time critical removal actions at OU 001. Based on the results of the EE/CA, a riverbank stabilization project and repairs to the landfill cover were initiated in January 1994 and completed in 1995.

2.2.6 Basis for Taking Action

The basis for taking action was unacceptable risk associated with direct contact with the waste and concentrations of COCs in groundwater that exceeded the MCLs. COCs were not identified for other media.

2.3 Remedial Actions

2.3.1 Remedial Action Objectives

The ROD for OU 001 was approved on 6 August 1997. The Remedial Action Objectives (RAOs) established for OU 001 were:

- Minimize human and ecological direct contact with landfill contents;
- Reduce the potential for leachate generation by reducing stormwater ponding and infiltration as practical;
- Stabilize the Kansas River bank slope adjacent to OU 001 to prevent movement of the channel into the landfill and to prevent exposure and erosion of the landfill contents; and
- Prevent ingestion, inhalation, and dermal contact with groundwater having organic contaminant concentrations that exceed remediation goals.

2.3.2 Remedy Selection

The remedy for OU 001 included ICs, maintaining the landfill cover, riverbank stabilization, groundwater monitoring and a contingency for future remediation of groundwater.

Institutional controls included signage, restrictions on future site uses, and prohibiting the use of groundwater. Restrictions on future site uses also included restricting the construction of structures that involve excavation for foundations, restricting the permanent occupancy of any structure, and limiting future utility easements to the outside edge of the landfill.

The objectives of groundwater monitoring were to detect increases in contaminant concentrations in the vicinity of OU 001 which would warrant additional actions and to determine if constituents from OU 001 were migrating under Threemile Creek. Groundwater monitoring would also be used for developing a better understanding of groundwater flow paths. The remediation goals (RGs) for the COCs for groundwater as presented in the ROD are shown on Table 2-2.

Table 2-2
OU 001 Groundwater Remediation Goals

Analyte	Remediation Goal[1] (μg/L)	Basis
Benzene	5	MCL
1,2-Dichloroethane	5	MCL
cis-1,3-Dichloropropene	0.28, 2.8, 28	Cancer Risk 1E-06, 1E-05, 1E-04
1,1,2,2-Tetrachloroethane	0.042, 0.42, 4.2	Cancer Risk 1E-06, 1E-05, 1E-04
1,1,2-Trichloroethane	3	MCL
Vinyl Chloride	2	MCL

[1] Remediation goal based on May 1993 USEPA MCL or where no MCL available, 1993 Region 9 Preliminary Remediation Goals (PRGs)

According to the ROD, the groundwater monitoring program "*may be modified, including reduction or cessation, if monitoring results warrants and a 5 year review justifies*."

Annual inspections would be conducted to monitor the cover conditions. Long-term maintenance would include mowing, periodic burning, seeding, and fertilizing to maintain the grass. Filling and other earthwork might be required to correct long-term settlement or erosion. Revegetating might also be required in eroded areas particularly after dry years.

2.3.3 Remedy Implementation

Fort Riley completed additional landfill cover repairs in June 2002 and November 2006 that included filling settled areas in the cover. The riverbank stabilization structure was also extended 100 feet upstream in November 2006 to reduce the risk that the river could erode behind the structure.

The Remedial Action Closure Report (RACR) was approved by USEPA in February 2010. The site was determined to be functionally stable and to have reached the "site completion" milestone under CERCLA.

Institutional controls were implemented at the SFL through the Fort Riley RPMP. The RPMP identified an area of influence around the landfill and specified what activities were restricted within the area of influence. Restricted activities included drilling water wells, digging/trenching, the use of track vehicles, and building construction/demolition. A Long-Term Management Control Plan (LTMCP) for OU 001 was completed in March 2011. The LTMCP stated that the plan would:

> *Keep the landfill in the restricted category in the installation's RPMP. Maintain the SFL site institutional control features. This will preclude drilling of a drinking water well, any building construction, excavation, and other incompatible uses as given in the RPMP.*
>
> *The institutional controls found in the RPMP are considered when each proposed project at Fort Riley undergoes its screening by Fort Riley's National Environmental Policy Act coordinator. The fencing and signage are to be maintained.*

A Land Use Control Implementation Plan (LUCIP) was prepared in October 2015. The purpose of the LUCIP was to maintain Land Use Controls (LUCs). The LUCIP identified specific Land Use Controls (LUCs) at OU 001, including restrictions on the installation of drinking water wells. The LUCIP noted that LUCs were functioning in accordance with the ROD and that no new LUCs were anticipated for OU 001.

2.3.4 Operation and Maintenance

In accordance with the ROD, the Operations and Maintenance (O&M) Plan consisted of annual inspections of the landfill cover, riverbank stabilization as needed, and groundwater monitoring.

Groundwater monitoring data have been collected at OU 001 for 32 years. The groundwater monitoring program focused on the perimeter of the landfill and originally included groundwater sampling and analysis for Volatile Organic Compounds (VOCs), antimony, and lead. Analysis for antimony was discontinued in December 1999, and analysis for lead was discontinued in January 2007. Nine wells are used to monitor groundwater. Two groundwater monitoring events have been conducted at OU 001 since the previous FYR. These monitoring events were conducted in November 2013 and May 2016.

Field parameters monitored included Dissolved Oxygen, Oxidation-Reduction Potential (ORP), Temperature, Turbidity, Conductivity, pH, and Iron (II). Laboratory parameters monitored included Method 8260 VOCs. In February 2010, USEPA approved the request from Fort Riley to reduce the groundwater monitoring frequency from an annual to a five-year schedule to coincide with five-year reviews.

Inspections of landfill cover at OU 001 were conducted annually between 2007 and 2016. Inspections since the previous FYR were conducted in May of 2013, 2014, 2015, and 2016. In May 2013, the landfill inspection noted differential settlement, ponded areas, and grasslike marsh plants on the landfill surface. An area containing empty drums was also observed in the northern corner of the landfill which had not been noted in previous inspections. Due to the conditions of the drums and their partial burial, it was assumed that the drums had been disposed of in the distant past, but had been obscured by brush during previous inspections. All drums appeared empty, with no residual liquids present. They were removed by Fort Riley in August 2013. Information provided by Fort

Riley PWE in support of this FYR, indicated that the empty drums may have been used for purge water, Investigation Derived Waste (IDW), from historic monitoring events. The current procedures at Fort Riley are that drums of IDW are removed to a secure yard and sampled. After testing shows that the IDW being non-hazardous, the wastewater would have been placed in the sanitary wastewater system. In addition, the May 2013 inspection report noted an area with some erosion due to washout from a small tributary to the Kansas River.

The 2014 annual landfill inspection was conducted in May 2014. Deficiencies observed included multiple areas with differential settlement, low areas with standing water, and erosion of the riprap along the Kansas River. No drums or suspect containers were identified during the inspections. Scattered isolated debris was observed on the landfill surface. Debris consisted of tin cans, concrete, wood, and other construction material. The material was located sporadically across the landfill and did not appear to be associated with waste from a trench being exposed through a capped cell but rather *de minimis* surface debris. Saplings were also noted along the southern perimeter of the landfill and in the riprap along the Kansas River. However, the saplings did not appear to be adversely affecting the performance of the stabilization structure, and did not need to be removed. A small area of riprap and subgrade soil was eroded on the eastern end of the bank stabilization structure. The report noted that an area that appeared to have been repaired several years ago, as erosion control material was visible along the edges of the erosion feature.

Repairs were made to the landfill cover in December 2014. The objective of the landfill cover repairs was to fill in surface depressions on the landfill cover over trenches to prevent ponding, and to repair an eroded riprap drainage feature located along the armored slope that abuts the Kansas River to prevent further erosion. Approximately 9,448 cubic yards of backfill material were used to repair the landfill cover, with each repaired area topped with an additional 1 to 2 inches of soil to promote positive drainage. Restoration activities included fertilizing, mulching and reseeding of disturbed areas.

Riprap repairs in December 2014 included clearing of existing woody vegetation, and then grading and shaping using heavy equipment. The side slopes of the existing drainage feature were cut back to a minimum 2:1 (horizontal:vertical) ratio to help increase stability. The area was covered with a geotextile fabric which was pinned in place, and then covered with a layer of riprap. A riprap apron was constructed to convey runoff from the crest to the toe of the slope. The riprap used consisted of 24-inch Light Series Stone, as described in Kansas Department of Transportation standard specification *Section 1114, Stone for Riprap, Ditch Lining, and Other Miscellaneous Uses*.

The annual landfill inspection in May 2015 noted new green grass where repairs had been made in December 2014. The inspection noted differential settlement in three areas across the landfill, but only a few areas with standing water after periods of heavy rains. All areas of ponding water had grass growing in them and only held water after heavy rain events. All areas that were repaired in December 2014 had new grass growing on them and were in good condition. The areas that had ponding water appeared to be only temporarily flooded. Therefore, no immediate repair was recommended. No exposed landfill material was observed on the landfill. There were no deficiencies noted at the area where the rip rap had been placed adjacent to the Kansas River in December 2014.

OU 001 was inspected in May 2016. The inspection team consisted of two field personnel from HGL (Contractor); two representatives of the Fort Riley PWE; a representative of the KDHE; a representative of USEPA; and two representatives of USACE. The landfill surface, vegetative cover, signage, and monitoring wells were inspected and conditions documented with photographs and on the Record of Inspection forms. Photographs taken during this inspection are provided in Appendix F. The landfill cover was observed to be in good condition. A few items of note from the May 2016 inspection included the absence of standing water on the landfill, despite significant rainfall prior to the inspection; metal debris was visible on the surface of a small area on the east-central part of the landfill (Photo #7 in Appendix F); and that the vegetative cover was sparse in several small areas on the east side of the landfill (Photo #3 and #6 in Appendix F). The metal debris observed was not munitions-related and did not present a hazard, and therefore allowed to remain on-site (Figure 2-2).

Because the landfill had been burned just before the May inspection, HGL returned to the landfill on July 14, 2016, to observe whether the areas of sparse vegetation observed in May had recovered after the burn and showed signs of growth. Upon inspection it was noted that the landfill had been mowed for hay which was left in place to dry. Vegetation was observed on all former trenches, though minimal vegetation was observed on a few of the former trench locations. The main areas of sparse vegetation were observed on the former ponding area located on the east side of the landfill (Photos #8, #9, and #10 in Appendix F), a former trench area located on the south-central side of the landfill (Photo #12), and the northwestern former trench on the landfill (Photos #17 and #18 in Appendix F). All other trenches had a moderate to significant amount of vegetation. The 2016 annual inspection noted that the Fort Riley agronomist requested that any areas that have less than 1 plant per square foot be overseeded with the current CPR mix for Riley County at the appropriate time this fall. There were no deficiencies noted at the area where the rip rap had been placed in December 2014.

Fort Riley PWE confirmed that the areas of sparse vegetation noted during the May 2016 landfill inspection were reseeded in the fall of 2016.

O&M costs include groundwater sample collection, sample analysis and reporting, maintenance of the landfill cover and riverbank stabilization structure, and maintenance of the monitoring wells. Annual O&M costs for monitoring at OU 001 since 2012 are provided in Table 2-3.

Table 2-3
OU 001 Annual O&M Costs

Fiscal Year	Total Cost
2013	$62,291
2014	$30,049
2015	$29,903
2016	$36,320
2017	$38,283

2.4 Progress since the Last Five-Year Review

The Third FYR was completed in September 2012. The Third FYR concluded:

> *The remedy at the SFL (controlling future land use and site access through institutional controls; stabilizing the Kansas River bank along the southern perimeter of the landfill; repairing and improving the existing native vegetation and soil cover; prohibiting the future use of site groundwater; and implementing a long-term groundwater monitoring program) is currently protective of human health and the environment and will continue to be protective during long-term management and care. There are no complete soil or groundwater exposure pathways that presently result in unacceptable risks at the site.*

The Third FYR Report identified no issues that needed to be addressed to maintain the long-term effectiveness of the remedy. The activities conducted at OU 001 since the previous FYR are described in Section 2.3.4. The evaluation of groundwater water monitoring data since the previous FYR is discussed in Section 2.5.3.

2.5 Five-Year Review Process

2.5.1 Site Inspection and Interviews

The Site Inspection Checklist for OU 001 is provided in Appendix C. The site inspection was conducted on 14 December 2016 and consisted of observations of the engineering controls and a representative portion of the landfill cover. Photographs of OU 001 are included in Appendix D. USACE, Louisville District, personnel were accompanied on the site inspection of OU 001 by the Fort Riley PWE IRP Manager, USEPA Remedial Project Manager, and KDHE Project Manager.

Access to OU 001 was restricted by a locked gate, with concrete barriers extending away from the gate that prevented access to OU 001 on either side of the gate. Signs were in good condition and legible. Observations of landfill cover were limited because the area was heavily vegetated with tall native grasses. No inappropriate use of OU 001 was observed. No subsidence, standing water, or exposed waste were noted in the limited areas observed. The annual inspection of the landfill cover in May 2016, discussed in Section 2.3.4, provides a more detailed description of the condition of the landfill cover. The riverbank stabilization area was not observed in December 2016. However, the inspection did not identify any deficiencies in the riverbank stabilization area in May 2016.

The Fort Riley PWE IRP Manager provided an overview of activities at OU 001 and noted that there have been no exceedances of remediation cleanup goals for many years. He further indicated that inspections are conducted annually at OU 001 and that the remedy was functioning as intended.

The USEPA Remedial Project Manager reported that his overall impression of the environmental program for OU 001 was good and that he was kept well informed about the activities and progress related to the site. During the site inspection, he confirmed that he had participated in annual inspection in May 2016 and that the annual monitoring report accurately reported the conditions of the landfill cover and Kansas River stabilization area.

The KDHE Project Manager reported that her overall impression of the environmental program for OU 001 was positive and that she was kept informed about the activities and progress by participating in quarterly meetings. During the site inspection, she confirmed that she had participated in annual inspection in May 2016 and that the annual monitoring report accurately reported the conditions of the landfill cover and Kansas River stabilization area. Summaries of the interviews are provided in Attachment E.

2.5.2 Document Review

The FYR included a review of relevant project documents including the annual monitoring reports, technical reports, and operation and maintenance reports. For this FYR, the relevant documents included (in chronological order):

- Fort Riley, 1995, *Record of Decision, Southwest Funston Landfill, Operable Unit 001, Fort Riley, Kansas, September 1995;*
- Black & Veach, 2007, *Real Property Master Plan Digest, Fort Riley, Kansas* (August)
- Fort Riley, 2012, *Third Five-Year Review Report, Fort Riley, Junction City, Geary, Clay and Riley Counties, Kansas* (September);
- HydroGeologic, Inc., 2014, *2013 Long-Term Monitoring Report, Southwest Funston Landfill, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (July)
- USACE, 2013, *2013 Annual Inspection Report, Southwest Funston Landfill, Fort Riley, Kansa*s (May);
- HydroGeologic, Inc., 2014, *Final Landfill Repair Work Plan, Southwest Funston Landfill, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (August);
- HydroGeologic, Inc., 2014, *Site-Specific Work Plan, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (April);
- HydroGeologic, Inc., *2014 Annual Inspection Report, Southwest Funston Landfill (FTRI-003), Fort Riley, Kansas;*
- HydroGeologic, Inc., *2015 Annual Inspection Report, Southwest Funston Landfill (FTRI-003), Fort Riley, Kansas;*
- HydroGeologic, Inc., June 2015, *Construction Completion Report, Southwest Funston Landfill, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (June);
- Aerostar SES LLC., 2015, *Land Use Control Implementation Plan,* Fort Riley, Kansas (October);
- Hydrogeologic, Inc., 2016, *2016 Long-Term Monitoring Report, Southwest Funston Landfill (FTRI-003), Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (October);
- USEPA, May 2016, *Regional Screening Levels*; and
- Kansas Department of Health and Environment (KDHE), December 2016, *Kansas Risk-Based Screening Levels.*

2.5.3 Data Review

The FYR process consists of a review and evaluation of data generated since the previous FYR. Analytical results for groundwater in 2013 and 2016 are provided in Appendix F. Potentiometric surface maps for 2013 and 2016 are shown in Figures 2-3 and 2-4. Table 2-4 summarizes the detections of COCs at OU 001 in 2013 and 2016.

Table 2-4
OU 001 Summary of COC detections in 2013 and 2016

VOC Compound	**Units**	**MCL**[1]	**SFL92-301**		**SFL92-601**		**SFL92-403**		**SFL92-401**	
			11/13	5/16	11/13	5/16	11/13	5/16	11/13	5/16
Benzene	µg/L	5	**0.59 J**	ND	**1.9**	**2.3**	ND	ND	ND	ND
Vinyl chloride	µg/L	2	ND	ND	**0.48 J**	ND	ND	ND	ND	ND

[1] USEPA December 2016
Bold=detection
ND=Not Detected
J=Estimated

There were no exceedances of remediation goals in 2013 and 2016. A review of historical data indicated that there have been no exceedances of the remediation goals at OU 001 since March 2007. Figures 2-5 and 2-6 show the location of wells with detected COCs in 2013 and 2016, respectively.

The RG for benzene is 5 µg/L. It was detected in a well in the disposal area (SFL92-601) at concentrations of 1.9 µg/L and 2.3 µg/L in 2013 and 2016, respectively. Benzene was also detected in a downgradient well adjacent to the Kansas River (SFL92-302) with a concentration of 0.59 µg/L.

The RG for VC is 2 µg/L. VC was the only other detected VOC in 2013, with a concentration of 0.48 µg/L, in the well located within the landfill limits.

2.6 Technical Assessment

The objective of the Five-Year Review is to evaluate if the remedial action at OU 001 will be protective of human health and the environment. The technical assessment of the protectiveness of the remedy is based on the responses to these three questions:

Question A: *Is the remedy functioning as intended by the decision documents?*

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

Question C: *Has any other information come to light that could question the protectiveness of the remedy?*

Question A: Is the remedy functioning as intended by the decision documents?

The answer to Question A is "Yes".

The basis for action at OU 001 was the presence of solid waste and VOCs in groundwater. The RAOs were to 1) minimize human and ecological direct contact with landfill contents; 2) reduce the potential for leachate generation by reducing storm-water ponding and infiltration as practical; 3) stabilize the Kansas River bank slope adjacent to OU 001 to prevent movement of the channel into the landfill and prevent exposure and erosion of the landfill contents; and 4) prevent ingestion, inhalation, and dermal contact with groundwater having organic contaminant concentrations that exceed remediation goals. The selected remedy for OU 001 was maintaining the landfill cover and ICs. According to the ROD, the purpose of long-term groundwater monitoring was to determine a need for further remedial action, The ROD also indicated that the groundwater monitoring program "*may be modified including reduction or cessation if monitoring results warrant and a 5 year review justifies.*"

Remedial Action Performance and Systems Operations/O&M

The RAOs to minimize human and ecological direct contact with landfill contents and reduce the potential for leachate generation continue to be met by repairs made as needed. As discussed in Section 2.3.4, empty drums observed during the previous FYR were removed in August 2014. Repairs made in 2014 included placement of 9,448 cubic yards of backfill in low areas with an additional 1 to 2 inches of soil to promote positive drainage. Restoration activities included seeding, fertilizing, mulching and reseeding of disturbed areas. During the most recent inspection in May 2016, only minor ponding following a storm was observed. Some sparsely vegetated areas were noted and it was recommended that they be reseeded. Based on interviews with Fort Riley personnel, the areas were subsequently reseeded. Observations of the landfill cover were limited by heavy vegetation during the site visit for the FYR. However, no repair was warranted based on the annual landfill inspection in May 2016.

Repairs were also made to the riverbank adjacent to the Kansas River in December 2014 based on the observations during the 2014 annual landfill inspection. The purpose of the repairs was to prevent erosion of the riverbank and exposure of waste. Repairs made included placement of rip rap along the southern edge of the landfill. Geotextile was placed underneath the rip rap. No deficiencies in the riverbank stabilization area were noted during the annual inspection in May 2016. This area was not inspected as part of the FYR because of physical access limitations. However, interviews with Fort Riley PWE IRP Manager, USEPA Remedial Project Manager, and KDHE Project Manager, who participated in the inspection in May 2016 confirmed that the annual report accurately represented conditions observed along the Kansas River bank slope. Based on the review of inspection reports, site inspection, and interviews, the O&M program for OU 001 appears effective in identifying actions needed to maintain and repair the landfill cover and prevent erosion along the Kansas River that could result in exposure to landfill contents.

Additional evidence that the remedy is effective in meeting RAOs for reducing leachate are the results of groundwater monitoring in 2013 and 2016. Groundwater monitoring data have been collected for 32 years. There have been no exceedances of current cleanup standards for VOCs in the wells sampled since 2007. In 2016, benzene was the only COC detected, in one well, within the former landfill boundary. Benzene was detected with a concentration of 2.3 µg/L, below the RG of 5 µg/L. Based on the results of long-term groundwater monitoring, further monitoring does not appear necessary to maintain the protectiveness of the remedy.

Implementation of Institutional Controls

The RAOs to "minimize human and ecological direct contact with landfill contents" and "prevent ingestion, inhalation, and dermal contact with groundwater having organic contaminant concentrations that exceed remediation goals" have been met by implementation of ICs that prevent exposure to waste and future use of groundwater.

For the ICs involving land use and access controls, the Fort Riley land use and planning documents include restrictions on the type of development at OU 001 (i.e., restrict construction of structures that involve excavation for the foundation and restrict the permanent occupancy of any structure), restrictions on future utility easements (i.e., limit future utility easements to outside the edge of the landfill), and prohibition on groundwater use in the vicinity of the landfill.

There are no structures at OU 001. ICs have been implemented and maintained at Southwest Funston Landfill through the 2006 RPMP and 2011 Long –Term Management and Care Plan (LTMCP). In 2015, a Land Use Control Implementation Plan (LUCIP) was also prepared to ensure that current and future activities are compatible with land use restrictions. The LUCIP identifies several processes that ensure the LUCs remain effective including "Site Approval Process" for reviewing and approving excavation and construction projects, as well as other land use changes on the installation. Based on interviews with Fort Riley Environmental Personnel, this process is being followed as part of the installation's compliance with the National Oil and Hazardous Substances Pollution Contingency Plan (NEPA). The Fort Riley NEPA Coordinator provides proposals for projects that could impact IRP sites to the Environmental Division for review.

During the FYR, landfill inspection reports for 2013, 2014, 2015, and 2016, were reviewed and confirmed that in addition to inspection of the landfill cover and river bank stabilization area, signage is also inspected. The signage was also noted to be present, in good condition, and legible during the site inspection for the FYR.

Implementation and enforcement of LUCs ensures that the remedy remains protective by preventing activities that could result in unacceptable exposure to waste or groundwater.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

The answer to Question B is "Yes".

The fourth FYR process included a review of the screening criteria, toxicity data, exposure assumptions, and remedial action objectives that were used at the time of the remedy selection. The primary objective of this review is to evaluate if these data, criteria, assumptions, and objectives are still protective of human health and the environment.

Exposure Assumptions: There have been no changes in land use since the ROD for OU 001 was approved in 1995. OU 001 was identified as a closed landfill. It is designated as "Open Space" in the RPMP, and has activity-based restrictions. There are no structures at OU 001. Restricted activities include: building construction, use of tracked vehicles, digging and trenching, and digging drinking water wells. As a result, no direct contact pathways exist for exposure to waste, groundwater, or vapor intrusion. No unacceptable exposures to waste, groundwater, or vapor intrusion are anticipated in the future.

The current environmental setting at the site is consistent with the findings at the time the ROD was approved. The OU is typical habitat for wildlife species inhabiting the Flint Hills region of Kansas. However, no aquatic habitat is present at the site. Therefore the findings of the RI are still applicable. No ecological risks are associated with the site and no further evaluation is needed.

Screening Criteria and Toxicity Data: The numerical remediation goals established in the ROD were based on MCLs for benzene, 1,2-Dichloroethane, 1,1,2-Trichloroethane, and VC. Risk-based goals were established for *cis*-1,3-Dichloropropene and 1,1,2,2-Tetrachloroethane.

MCLs have remained unchanged since approval of the ROD. Because the MCLs were used as screening values for the risk assessment, changes in the risk-based screening levels for several COCs would not affect the choice of COCs, the conclusions of the risk assessment, or the protectiveness of the remedy. Risk-based goals were established in the ROD for cis-1,3-Dichloropropene and 1,1,2,2-tetrachloroethane at cancer risk screening levels of 1E-06, 1E-5, and 1E-4. A comparison of risk-based goals established in the ROD for cis-1,3-Dichloropropene (0.28 μg/L) and 1,1,2,2-tetrachloroethane (0.042 μg/L) to the current most conservative risk-based screening levels (1E-6) (USEPA Regional Screening Levels, May 2016) indicate that the current levels are higher, at 0.47 μg/L and 0.078 μg/L, respectively.

Toxicity data was reviewed for groundwater to determine if changes since the ROD could affect the protectiveness of the remedy. Toxicity data for numerous chemicals have changed since 1993, including benzene and VC, which were detected in groundwater between 2012 and 2016. Prior to 2009, Preliminary Remediation Goals (PRGs) and MCLs were used as the source of risk-based screening criteria to identify COCs. Since completion of the RI, the PRGs have been renamed as the Regional Screening Levels (RSLs). Underlying toxicity data to evaluate risk include slope factors used to evaluate cancer effects from oral and dermal exposure, inhalation unit risk values used to evaluate cancer effects from inhalation, reference doses used to evaluate non-cancer hazards from oral and dermal exposure, and reference concentrations used to evaluate non-cancer hazards from inhalation. Toxicity data have changed for benzene and VC. A comparison of changes in toxicity data indicated that the reference dose is now higher for benzene and the chemical is therefore considered less toxic via direct contact routes. The cancer slope for VC is now lower and VC is now considered a less potent carcinogen via direct contact routes. Because the current remedy prohibits use of groundwater, and thus potential ingestion or dermal contact, the remedy would still be protective.

The baseline risk assessment did not evaluate the vapor intrusion (VI) pathway because there were no structures at OU 001. However, this pathway was evaluated as a component of the previous FYR using Vapor Intrusion Screening Level (VISL) calculator and RSLs for indoor-air. None of the detected concentrations exceeded conservative groundwater screening criteria for potential impact to indoor air. A groundwater screening level for indoor air was not available for *cis*-1,3-dichloropropene in 2012. The groundwater screening value for *cis*-1,3-dichloropropene is currently 21 µg/L. This COC was not detected in groundwater in 2013 or 2016. Therefore, the VI pathway is not expected to pose an unacceptable risk at this site.

ARARS and TBC Criteria: The ROD identified the principal ARARs which are relevant and appropriate for OU 001 as MCLs and Resource Conservation and Recovery Act (RCRA) Subtitle D, Criteria for Municipal Solid Waste Landfills (40 CFR 258.60 and 258.61), which have not changed. The ROD also identified action- and location-specific standards, such as endangered and/or threatened species, floodplain, historical, and RCRA requirements, which have not changed.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

The answer to Question C is “No”.

No other information has come to light that could call into question the protectiveness of the remedy.

2.7 Technical Assessment Summary

The selected remedy for OU 001, Southwest Funston Landfill was maintaining the landfill cover and riverbank stabilization structure, and implementation of ICs. Numerical remediation goals were also developed for the COCs identified for groundwater. Based on review of documents, interviews, and site inspection, the remedy has been implemented and is functioning as intended by the decision documents.

The RAOs, including repairs to the landfill cover, riverbank stabilization, and implementation of ICs have been met. In addition, the RGs identified in the ROD for OU 001 have been achieved. The remedy is currently protective of human health and the environment based on the implementation and enforcement of ICs and maintenance of the landfill cover which prevents exposure to waste and groundwater. VI is not an environmental concern at OU 001 based on the absence of structures. The remedy is expected to remain protective in the future with continued enforcement of ICs and inspection and maintenance of the landfill cover.

2.8 Issues

There were no issues found affecting protectiveness of the remedy.

2.9 Recommendations and Follow-Up Actions

No issues that could affect current and/or future protectiveness were identified for OU 001. Therefore, no follow-up actions are required at this time.

Other Findings

The following recommendation was identified during the FYR and (may improve performance of the remedy, reduce costs, improve management of O&M, accelerate site close out, conserve energy, promote sustainability, etc.), but does not affect current and/or future protectiveness:

- It is recommended that the groundwater monitoring program at OU 001 be terminated. According to the ROD, the purpose of long-term groundwater monitoring was to determine a need for further remedial action. The ROD also indicated that the groundwater monitoring program "may be modified including reduction or cessation if monitoring results warrant and a 5 year review justifies." Groundwater monitoring data have been collected for 32 years, and results indicate that the remedy, consisting of a landfill cap and O&M, is effective in maintaining protectiveness of the remedy. There have been no exceedances of RGs in the wells sampled since 2007. In 2016, benzene was the only COC detected, in one well, within the former landfill boundary. Benzene was detected with a concentration of 2.3 µg/L, below the RG of 5 µg/L.

2.10 Protectiveness Statement

The remedy for OU 001, Southwest Funston Landfill, is protective of human health and the environment.

The remedy, which consists of maintaining a landfill cover and ICs, remains protective by:

- Preventing direct exposure to buried waste;
- Preventing degradation of the underlying groundwater by minimizing migration of potential constituents from waste to groundwater; and
- Preventing exposure to groundwater by enforcement of ICs that prohibit drilling and installation of water wells, or other activities that could damage the integrity of the landfill cover.

3.0 Dry Cleaning Facilities Area, OU 003

3.1 Chronology of Key Events

Table 3-1
Chronology of Key Events at OU 003

Event	Date
Buildings 180/181 operated as a laundry	1915 – 1983
Buildings 180/181 operated as dry cleaning facilities	1930 – 1983
Building 183 operated as a laundry	1941 – 2002
Building 183 operated as a dry cleaning facility	1983 – 2002
FFA Requires Site Investigation of former Dry Cleaners	June 1991
Preliminary Assessment/Site Inspection (PA/SI)	1991 – 1992
Remedial Investigation/Feasibility Study (RI/FS)	February 1993 – March 1998
Soil Vapor Extraction and Groundwater Extraction Pilot Studies Initiated	May 1994
Soil Vapor Extraction Pilot Test	November – December 1994
Proposed Plan	December 1998
KDHE Dispute and Resolution	January – April 1999
Work Plan Addendum	March 2002
Phase 1 Field Work – OU 003 Geoprobe	May – July 2002
Phase 2 Field Work – Training Area (TA2) Geoprobe	October 2002
Final RI Work Plan Addendum Building 183	June 2003
Install TA2 Monitoring Wells	July 2003
Collect Building 183 Soil Samples	July 2003
RI Report Addendum	April 2004
Feasibility Study Addendum (Cancelled vice Pilot Study)	May 2004
USEPA approves Fort Riley request to abandon 29 monitoring wells, to change sampling frequency from semi-annual to annual, and to limit analysis to COCs	March 2005
Pilot Study Work Plan approved	August 2005
Pilot Study Field Work	October – November 2006
Record of Decision approved	18 March 2008
Pilot Study Report	January 2008
Revised Work Plan – CAP 18™ Injection Project Environmental Remediation Services	October 2009
CAP 18™ Injection and treatment.	February 2010
Technical Memorandum – CAP 18™ Injection Project approved. Confirmation sampling demonstrated remediation of soil	October 2010
First Five-Year Review	20 September 2012
Bench-Scale Microcosm Study	November 2015

3.2 Background

3.2.1 Introduction

OU 003, Dry Cleaning Facilities Area, is an IRP site and is identified in the Fort Riley IAP as FTRI-027. The Dry Cleaning Facilities Area, OU 003, is also referred to by the acronym "DCA" or "DCFA" in some supporting documents. OU 003 is a former dry cleaning facilities area located in the southwestern corner of the main post cantonment area, north of the Kansas River. The site consists of five separate, but related areas (Figure 3-1):

- Former dry cleaning facilities (Buildings 181/182/183);
- The Transition Zone (a change in soil type located between the former dry cleaning facilities and a point bar ("Island")next to the Kansas River);
- Horse Corral (east of the Island where horses are trained); and
- Training Area 2 (located south of the river where the Army holds field exercises).

3.2.2 Physical Characteristics

The topography across OU 003 is dominated by alluvial terraces, a soil Transition Zone, point bars (the Island and the Horse Corral Area) of the Kansas River, and the Kansas River Floodplain. Figure 3-2 is a schematic representation of the conceptual site model for OU 003. The alluvial terrace consists of clays, sands and silts overlying Permian-age alternating shales and limestones. The Transition Zone separates the alluvial terraces from the river alluvial deposits that underlie the Island and the Horse Corral. The east/west Union Pacific Rail Road (UPRR) tracks lie within the Transition Zone. The Island is a heavily wooded point bar that serves as a winter roosting area for bald eagles. The Horse Corral is the western portion of a point bar located downstream (east) of the Island. The Horse Corral is used for pasture and training of horses. Training Area 2 (TA2) is located on the south side of the Kansas River and the Island. The area is heavily wooded and is used for military exercises.

3.2.3 Land and Resource Use

The Fort Riley RPMP designates OU 003 study area as an "Open Space", in which future development for residential or commercial industrial use is not permitted. There are no buildings at OU 003. Open areas have building restrictions and are used only for safety areas, utility clearances and easements, conservation areas, and buffer zones. It is anticipated that land use activities within OU 003 will remain unchanged into the foreseeable future based on building restrictions.

Fort Riley water supply wells are located approximately three miles upgradient from OU 003.

A portion of OU 003 lies within the bald eagle nesting area on both sides of the Kansas River.

3.2.4 History of Contamination

Dry cleaning operations were conducted at Buildings 180/181 from 1930 until 1983. Dry cleaning operations were conducted at Building 183 from 1983 to 2002. Stoddard solvent, a petroleum distillate mixture, was used as the dry cleaning solution from 1944 until 1966. From 1966 until dry cleaning operations ceased, tetrachloroethene (PCE) was used as the cleaning solution. Buildings 180/181 and the surrounding structures, parking lots and sidewalks, were demolished in summer 2000. Building 183 and the surrounding structures were demolished in fall 2002. Remedial investigations to characterize potential contamination at OU 003 were completed in 2004. The studies confirmed that leaking sewer lines had resulted in soil and groundwater contaminated with PCE. Three Areas of Concern (AOCs) were identified based on exceedances of KDHE RSKs in soil and groundwater: AOC 1 and AOC 2 addressed soil and groundwater contamination, respectively, at former Buildings 180/181. AOC 3 addressed both soil and groundwater contamination located in portions of the Transition Zone and the Island. An additional groundwater plume, "Other Areas", was identified near the Island and Horse Corral.

3.2.5 Initial Response

Response actions conducted at OU 003 prior to approval of the ROD included a soil vapor extraction pilot study in the vicinity of AOCs 1 and 2 in 1994 and 1995. An estimated 24 pounds of contaminants, primarily PCE, were removed during this effort.

In 2005 and 2006, a soil source removal pilot study was conducted at AOC 1. Approximately 2,400 cubic yards of soil were excavated near the Building 180 footprint. Select abandoned-in-place sewer lines were also excavated. A 10% sodium permanganate solution was also injected into sewer lines to oxidize any remaining chlorinated hydrocarbons. A groundwater treatment pilot study was conducted at AOC 2 that included injection of approximately 8,200 pounds of CAP 18^{TM}, a non-emulsified soybean oil product, at 72 different points into groundwater at AOC 2.

In 2005, an aqueous solution of sodium permanganate was injected into the vadose zone near MW DCF02-42 in AOC 3. Approximately 7,400 pounds of sodium permanganate were injected at 23 locations. A second pilot study in the same area was conducted in 2006 to evaluate the injection of potassium permanganate into the saturated zone. Potassium permanganate was injected at 44 different locations between the two wells.

In 2006, CAP 18^{TM} was injected into the "Other Areas" near MW DCF02-49C (the Island) and DCF99-37C and 354-99-11C (Horse Corral). Approximately 5,530 pounds was injected at 37 injection points.

3.2.6 Basis for Taking Action

The basis for taking action at OU 003 was the unacceptable risk associated with potential future use of groundwater as a drinking water source due to its hydraulic connection to the Kansas River. Drinking water standards were considered relevant and appropriate as cleanup levels. According to the ROD, clean-up levels at OU 003 are defined as MCLs. Four VOCs (PCE, trichloroethene (TCE), cis-1,2-Dichloroethene (*cis*-1,2-DCE), and VC) in the Kansas River alluvial aquifer exceeded the drinking water MCLs.

3.3 Remedial Actions

3.3.1 Remedial Action Objectives

The ROD for OU 003 was approved on 18 March 2008. The RAOs developed for the site were based on the major findings of the investigations, feasibility study, and pilot studies that are summarized in Sections 3-2-4 and 3-5. The RAOs developed for OU 003 were to:

- *Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration in groundwater of COCs that exceed cleanup goals.*

- *Achieve cleanup goals of MCLs for COCs in groundwater in the Kansas River alluvium through the use of natural and/or active remedial processes.*

3.3.2 Remedy Selection

The selected remedy to meet the RAOs was monitored natural attenuation (MNA) with ICs. The remedy relies on natural degradation processes already occurring to further reduce contaminant concentrations below their respective MCLs. The ROD called for groundwater monitoring annually for three years (2008, 2009, and 2010), followed by sampling every five years, thereafter. According to the ROD, once the alluvial wells were below MCLs, OU 003 could be recommended for site closeout.

The numerical remediation goals established for OU 003 were the drinking water standards, or MCLs, as follows:

PCE:	5 µg/L
TCE:	5 µg/L
cis-1,2-DCE:	70 µg/L
VC:	2 µg/L

ICs included restricting residential land use, limiting public access, prohibiting installation of drinking water wells and groundwater use in the area, and involving the Fort Riley PWE personnel in proposed future plans for the site.

3.3.3 Remedy Implementation

A Remedial Design/Remedial Action Plan (RD/RA) for OU 003 was produced in June 2008 to identify and describe remedy activities to be conducted in order to accomplish each of the components of the remedy. The groundwater monitoring program for the DCF Study Area was based on more than 16 years of groundwater sampling, evaluation, and trend analyses. The RD/RA plan called for wells selected for long-term monitoring to be sampled annually for a minimum of 3 years, followed by 5-Year Review sampling as necessary. The data was to be evaluated following each monitoring event to determine if further sampling was necessary.

ICs were implemented at OU 003 in 2008. The Fort Riley RPMP restricts building construction and demolition, digging and trenching, and installation of drinking water wells at OU 003. The ICs have been enforced through annual inspections and the dig permitting procedures that are monitored by PWE personnel.

A LUCIP was also prepared in 2015 to ensure that current and future activities are compatible with land use restrictions. The LUCIP identifies several processes that ensure the LUCs remain effective including "Site Approval Process" for reviewing and approving excavation and construction projects, as well as other land use changes on the installation. Based on interviews with Fort Riley PWE personnel, this process is being followed as part of the installation's compliance with the NEPA.

The LUCIP indicated that the LUCs at OU 003 were functioning in accordance with the appropriate ROD and Five-Year Reviews, and are to be protective of human health and the environment. No new LUCs were anticipated for OU 003.

3.3.4 Operation and Maintenance

There is no active remediation system at OU 003. Groundwater monitoring at OU 003 has been conducted in May 2013, April 2014, May 2015, and May 2016, since the previous FYR. In accordance with the RD/RA Work Plan, the data was evaluated following each monitoring event to determine if further sampling was necessary. Field parameters monitored included Dissolved Oxygen (DO), ORP, temperature, conductivity, pH, and iron (II). Laboratory parameters monitored included Method 8260 VOCs. MNA parameters included methane, ethane, ethene (MEE), alkalinity (total as CaCO3), chloride, nitrogen (nitrite and nitrate), sulfate and sulfide. Analytical results for groundwater since the previous FYR are provided in Appendix G.

During the groundwater monitoring event in May 2013, a total of 27 wells were inspected and gauged and 24 wells were sampled. The gauging data indicated groundwater flow southwest toward the Kansas River. Analytical data indicated VOCs exceeding MCLs in 9 wells.

In April 2014, a total of 22 wells were inspected, gauged and sampled. The gauging data indicated groundwater flow southwest toward the Kansas River. Analytical data indicated VOCs exceeding MCLs in 6 Long-Term Monitoring wells.

A microcosm study was performed in 2015 to determine if an indigenous microbial community was present in the sediments that could degrade the PCE. The study concluded that bioremediation was occurring at OU 003. The study also concluded that injection of additional soybean emulsion could stimulate rate of bioremediation at the site. However, Fort Riley concluded that further treatment was not warranted based on physical site conditions and access limitations at source areas.

In May 2016, 25 wells were gauged. Consistent with previous gauging, groundwater flow was generally southwest toward the Kansas River. A total of 18 wells were sampled and analyzed for VOCs and MNA parameters. VOCs were detected above MCLs in six monitoring wells. The annual monitoring report recommended that annual monitoring be continued. Further discussion of the groundwater monitoring events is provided in Section 3.5.3.

Annual O & M costs for OU 003 since the previous FYR are provided in Table 3-2. Up to 25 wells have been sampled in recent sampling events at OU 003.

Table 3-2
OU 003 Annual O&M Costs

Fiscal Year	Total Cost
2013	$38,492
2014	$38,492
2015	$33,580
2016	$30,413

3.4 Progress since the Last Five-Year Review

The Third FYR was completed in September 2012. The Third FYR concluded:

> *The remedy at the DCFA Site (OU 003), Monitored Natural Attenuation with institutional controls, is currently protective of human health and the environment, and will continue to be protective long-term. Monitoring of natural attenuation is showing that COCs in groundwater are decreasing. Institutional controls, as documented in the RPMP and RD/RA* [remedial design/remedial action] *Plan are blocking exposure pathways that could potentially result in unacceptable risks.*

The Third FYR Report identified no issues that needed to be addressed to maintain the long-term effectiveness of the remedy. The activities undertaken at OU 003 since the previous FYR are discussed in Section 3.3.4. The results of groundwater monitoring and trend analysis since the previous FYR are discussed in detail in Section 3.5.3. The evaluation of the data, status of the remedy, and impact on protectiveness are discussed in Section 3.6.

3.5 Five-Year Review Process

3.5.1 Site Inspection and Interviews

A Site Inspection Checklist for OU 003 is provided in Attachment C. The site inspection consisted of visual inspection of monitoring wells from upgradient areas near Building 354 to downgradient areas near the Kansas River that were accessible by vehicle. Wells were observed to be in good condition with locks in place. Photographs of OU 003 are included in Appendix D.

The Fort Riley IRP Manager provided an overview of activities at OU 003 and provided an overview of the site history of OU 003. He noted that additional treatment of AOC 3 groundwater was evaluated and determined that it was not warranted based on difficulties with access and implementation. He further indicated that the remedy was functioning as intended and that land use restrictions prevent exposure to impacted groundwater.

The USEPA Remedial Project Manager reported that his overall impression of the environmental program for OU 003 was good and that he was kept well informed about the activities and progress related to the site. The KDHE Project Manager also reported that her overall impression of the environmental program for OU 003 was positive and that she reviews groundwater monitoring reports, and was kept informed about the activities and progress by participating in quarterly meetings. Summaries of the interviews are provided in Appendix E.

3.5.2 Document Review

The Five-Year Review consists of a review of relevant project documents, including annual monitoring reports, technical reports, and operation and maintenance reports. Documents reviewed for this Five-Year Review are as follows:

- Burns & McDonnell, 2008, *Record of Decision Dry Cleaning Facilities Area (Operable Unit 003) at Main Post, Fort Riley, Kansas,* January 2008;
- Black & Veach, 2007, *Real Property Master Plan Digest, Fort Riley, Kansas,* August;
- Fort Riley, 2012, *Third Five-Year Review Report, Fort Riley, Junction City, Geary, Clay and Riley Counties, Kansas* (September);
- Aerostar SES LLC., 2015, *Land Use Control Implementation Plan,* Fort Riley, Kansas (October);
- University of Kansas*, Microcosm/Bench-scale Studies for the DCFA Site, Fort Riley, Kansas*. University of Kansas. November 2015;
- HydroGeoLogic, Inc., *2015 Annual Long-Term Monitoring Report Dry Cleaning Facilities Area Operable Unit 003 (FTRI-027), Fort Riley, Kansas.* February 2016;
- HydroGeoLogic, Inc., *2016 Annual Long-Term Monitoring Report Dry Cleaning Facilities Area Operable Unit 003 (FTRI-027), Fort Riley, Kansas.* December 2016;
- USEPA, May 2016, *Regional Screening Levels; and*
- KDHE, 2016, Kansas Risk-Based Screening Levels.

3.5.3 Data Review

The Five-Year Review process consists of a review and evaluation of data generated since the previous FYR. Groundwater monitoring events were conducted in May 2013, April 2014, May 2015, and May 2016. Analytical data for 2013 through 2016 is provided in Appendix G. The groundwater potentiometric maps for 2013, 2014, 2015, and 2016 are shown in Figures 3-3, 3-4, 3-5, and 3-6. Concentrations for PCE, TCE, *cis*-1,2-DCE, and VC are depicted in Figures 3-7, 3-8, 3-9, and 3-10. The most recent (2016) analytical results for OU 003 are summarized in Tables 3-3 and 3-4.

Statistical evaluations using the Mann-Kendall trend analysis were prepared by HGL using data collected since the 2006 pilot study. The contaminant concentration trends for this data from wells in AOCs 1 and 2 are presented in Tables 3-5. The contaminant concentration trends for data from wells in AOC 3 are presented in Table 3-6. Both a “Stable” or “No Trend” result indicate that neither an “Increasing” nor a “Decreasing” trend can be determined with statistical confidence. The distinction between the “Stable” vs. “No Trend” outcomes is that the “Stable” trend is characterized by a more limited variability in the range of contaminant concentrations vs. time.

Table 3-3
2016 Summary Table of Detections in AOC 1 and 2

COCs	**MCLs**	**Treatment Area**			**Side-gradient Area**		
		DCF92-05	**DCF93-13**	**DCF06-40**	**DCF93-19**	**DCF93-20**	**DCF96-27**
PCE	5	**3.3**	ND	**3.8**	ND	**3.2**	**0.5 J**
TCE	5	ND	**0.81 J**	**0.55 J**	ND	**2.9**	**2.2**
Cis-1,2-DCE	70	ND	**73.4**	**2.2**	**4.3**	**4.5**	**21.8**
VC	2	ND	**7.5**	ND	**0.75 J**	ND	**0.32 J**
Downgradient Area (Island)							
		DCF02-41	**DCF02-44A**	**DCF02-44C**	**DCF02-47C**	**DCF02-48A**	**DCF02-48C**
PCE	5	ND	**12.4**	**18.5**	**6.2**	0.53 J	**11.0**
TCE	5	ND	**2.7**	**2.9**	**0.38 J**	**0.84 J**	**2.1**
Cis-1,2-DCE	70	**66.6**	**2.8**	**4.3**	ND	**3.6**	**2.3**
VC	2	**0.45 J**	ND	ND	ND	ND	ND

All units reported as µg/L
J = The analyte was detected at the reported concentration; the quantitation is an estimate.
MCL = U.S. EPA Maximum Contaminant Level (May 2016)
BOLD = detected
Shaded cell = result exceeded MCL

Table 3-4
2016 Summary Table of Detections in AOC 3

COCs	MCLs	Treatment Area		Down-gradient	
		DCF02-42	DCF06-25	DCF02-46A	DCF02-46C
PCE	**5**	**5.5**	**28.8**	**0.89 J**	**0.39 J**
TCE	5	**0.33 J**	**3.0**	**0.33 J**	ND
Cis-1,2-DCE	70	ND	**3.9**	**0.33 J**	ND
VC	2	ND	ND	ND	ND

All units reported as µg/L
J = The analyte was detected at the reported concentration; the quantitation is an estimate.
MCL = U.S. EPA Maximum Contaminant Level (May 2016)
BOLD = detected
Shaded cell= result exceeded MCL

Table 3-5
Contaminant Concentration Trends for wells in AOC 1 and 2

COCs	Treatment Area			Side-gradient Area		
	DCF92-05	DCF93-13	DCF06-40	DCF93-19	DCF93-20	DCF96-27
PCE	NT	D	D	NT	I	S
TCE	S	S	S	NA	PD	NT
Cis-DCE	NT	I	NT	NT	D	NT
VC	NA	I	NA	D	NA	NT
Downgradient Area						
	DCF02-41	DCF02-44A	DCF02-44C	DCF02-47C	DCF02-48A	DCF02-48C
PCE	NA	S	S	S	NT	S
TCE	D	NT	S	NT	D	NT
Cis-DCE	D	NT	S	NT	D	NT
VC	NA	NA	NA	NA	NA	NA

NA = Mann-Kendall trend not analyzed; insufficient number of detections to perform analysis.
D = decreasing trend   I = increasing trend   NT = no trend   S = stable
PD=probably decreasing trend

Table 3-6
Contaminant Concentration Trends for wells in AOC 3

COCs	Treatment Area		Down-gradient	
	DCF02-42	DCF06-25	DCF02-46A	DCF02-46C
PCE	S	NT	NT	NT
TCE	S	S	S	NA
Cis-1,2-DCE	NA	S	NA	NA
VC	NA	NA	NA	NA

NA = Mann-Kendall trend not analyzed; insufficient number of detections to perform analysis.
D = decreasing trend I = increasing trend NT = no trend S = stable

AOCs 1 and 2

AOCs 1 and 2 are discussed by Treatment Area wells, Side-Gradient Area wells, and Downgradient Area wells. The AOC 1 soil source removal action in 2005 included removal of approximately 2,400 cubic yards of soil, removal of soil from around abandoned sewer lines and manholes, and injection of oxidant for in-situ cleanup. During the oxidant injection, 3,692 gallons of 10 percent sodium permanganate solution were injected along the sewer lines, at associated manholes, and in the vicinity of the abandoned high-pressure gas line trench. In April of 2006, groundwater (AOC 2) was treated with approximately 8,200 pounds of CAP18™, an unsaturated vegetable oil-based product. Approximately 2,500 pounds of CAP18™ was injected though 10 injection points along the axis of the bedrock erosional channel in February of 2010.

Treatment Area.

Three monitoring wells are used to monitor COCs in the Treatment Area. They include DCF92-05, DCF93-13, and DCF06-40. There were no PCE exceedances of the MCL in the Treatment Area wells in 2016. PCE exceeded the MCL in DCF92-05 with 6 ug/L in 2012, decreasing to 3.3 ug/L in 2016. There were no PCE exceedances of the MCL in DCF93-13 between 2012 and 2016. PCE exceeded the MCL in DCF06-40 in 2012 and 2015. Statistical trend analysis (2006-2016) indicated decreasing concentrations of PCE in DCF92-95 and DCF06-40, and no trend in DCF92-05.

There were no TCE exceedances of the MCL in the Treatment Area wells between 2012 and 2016. There were no detections of TCE in DCF92-05 during the five year review period. Highest concentrations were detected in DCF06-40 in 2012 with 2.4 ug/L. Statistical trend analysis indicated stable trends for TCE in all three Treatment Area wells.

Concentrations of *cis*-1,2-DCE fluctuated between 14.3 ug/L and 73.4 ug/L over the five year period. Long term statistical trend analysis indicated a decreasing trend in DCF92-05, stable trend in DCF93-13, and no trend in DCF06-40.

There were no detections of VC in DCF93-05 and DCF06-40 over the five year review period. Concentrations of VC in DCF93-13 increased from 4.0 ug/L in 2012 to 7.5 ug/L in 2016. The statistical trend analysis indicated an increasing trend of VC in DCF93-13

The decreasing and stable trends for PCE and TCE, and increasing trend for VC results in DCF93-13 suggests that reductive dechlorination of PCE is occurring in the treatment area.

Side-Gradient Area

Three monitoring wells are used to monitor groundwater in the Side-Gradient Area. They include DCF92-19, DCF93-20, and DCF96-27. There were no PCE exceedances of the MCL in the Side-Gradient Area wells in 2016. PCE has not been detected in DCF93-19 since 2013. Highest concentrations of PCE in DCF93-20 were measured in 2014 at 4.0 ug/L. Concentrations decreased to 2.2 ug/L in 2015 and increased to 3.2 ug/L in 2016. Highest concentrations of PCE in DCF96-27 were also measured in 2014 at 4.1 ug/L, decreased to 1.9 ug/L in 2015, and increased to 0.5 ug/L in 2016. Long term statistical trend analysis indicated an increasing trend for PCE in DCF93-20, no trend in DCF93-19, and a stable trend in DCF96-27.

There were no TCE exceedances of the MCL in the Side-Gradient wells between 2012 and 2016, with the exception of a detection of 5.1 ug/L in DCF93-20 in 2013. TCE has not been detected in DCF93-19 since 2012. Concentrations of TCE in DCF93-20 decreased from 5.1 ug/L in 2013 to 2.8 ug/L in 2016. Concentrations of TCE in DCF93-27 fluctuated between 2.3 ug/L and 2.2 ug/L between 2012 and 2016. Statistical trend analysis indicated a probably decreasing trend in DCF93-20, and no trend in DCF96-27.

There were no *cis*-1,2-DCE exceedances of the MCL in the five year review period. Highest concentration in DCF93-19 were measured in 2013 with 13.1 ug/L. Highest concentration of *cis*-1,2-DCE in DCF93-20 was measured in 2013 with 12.3 ug/L, decreasing to 4.5 ug/L in 2016. Highest concentration of *cis*-1,2-DCE in DCF93-27 was measured 2013 with 28.6 ug/L. Statistical trend analysis for *cis*-1,2-DCE indicated no trends in DCF93-19 and DCF93-27, and a decreasing trend in DCF93-20.

There were no detections of VC exceeding the MCL in the Side-Gradient Area wells in the five year review period. There were no detections of VC in DCF93-20 between 2012 and 2016. In DCF93-19, VC fluctuated between 0.75 ug/L in 2016 and 1.3 ug/L in 2013. Concentrations of VC in DCF93-27 decreased from 0.79 ug/L in 2013 to 0.32 ug/L in 2016. Statistical trend analysis for VC indicated a decreasing trend in DCF93-19 and no trend in DCF93-27.

The increasing trend for PCE at well DCF93-20 may be an indication that PCE had migrated from the potential source area. However, PCE in the source area has been effectively reduced to levels below the MCL, and PCE concentration trend at DCF93-20 is likely to reverse with time.

Downgradient Area

Six monitoring wells are used to monitor COCs in the Downgradient Area. They include DCF02-41, DCF02- 44A, DCF02-44C, DCF02-47C, DCF02-48A and DCF02-48C. There were no detections of PCE in DCF02-41 between 2012 and 2016. Concentrations of PCE in DCF02-48A were detected at 1.1 ug/L in 2015 and 0.53 ug/L in 2016. Concentrations of PCE exceeded the MCL in the four remaining wells. PCE in DCF02-44A decreased from 25.5 ug/L in 2013 to 12.4 ug/L in 2016. PCE in DCF02-44C decreased from 27.5 ug/L in 2013 to 18.5 ug/L in 2016. PCE in DCF02-47C decreased from 18.0 ug/L in 2012 to 1.3 ug/L in 2015, then increasing to 6.2 ug/L in 2016. PCE in DCF02-48C fluctuated between 1.9 ug/L and 11.0 ug/L from between 2012 and 2016, with the highest detection in 2016. The statistical trend analysis indicated stable trends for PCE in all Downgradient Area wells, with the exception of DCF02-48A, which had no trend.

There were no exceedances of the MCL for TCE in any well in the Downgradient Area during five year review period. There were no detections of TCE in DCF02-41 between 2012 and 2016. Statistical trend analysis indicated decreasing trends for PCE in DCF02-41 and DCF02-48A, a stable trend in DCF02-44C, and no trend in DCF02-44A, DCF02-47C, and DCF02-48C.

There were no exceedances of the MCL for *cis*-1,2-DCE in any well in the Downgradient Area. Concentrations of *cis*-1,2-DCE exceeded the MCL in only one well, DCF92-41, in 2012, 2013, and 2014. Statistical trend analysis for *cis*-1,2-DCE in Downgradient Area wells indicated decreasing trends in DCF02-41 and DCF02-48A, A stable trend was indicated in DCF-02-44C, and no trend was indicated for DCF02-44A and DCF02-47C. Only one well had detections of VC over the review period. Concentrations of VC detected at 0.57 ug/L in 2014 and 0.45 ug/L in 2016.

AOC 3

Areas within AOC 3 are discussed by Treatment Area and Downgradient Area wells. A Pilot Study was conducted at AOC 3 in January and February 2006, and involved vadose zone injection of approximately 7,400 pounds of sodium permanganate solution at 23 locations near monitoring well DCF02-42. In April 2006, approximately 21,755 pounds of potassium permanganate were injected into the saturated zone between monitoring wells DCF02- 42 and DCF96-25.

Treatment Area

Two wells are used to monitor groundwater in the AOC 3 Pilot Study Area: DCF02-42 and DCF06-25. DCF02-42 was not sampled in 2013 and 2014. Concentrations of PCE in DCF02-42 decreased from 22.2 ug/L in 2015 to 5.5 ug/L in 2016. Concentrations of PCE in DCF06-25 ranged from 27 ug/L to 39.5 ug/L over the five-year review period with no discernable trend. Statistical trend analysis indicated a decreasing trend for TCE in both wells in the Treatment Area Wells.

Concentrations of TCE in DCF02-42 were measured at 0.28 ug/L, 2.3 ug/L, and 0.33 ug/L, in 2012, 2015, and 2016, respectively. TCE exceeded the MCL in DCF06-25 in 2013 at 5.5 ug/L, decreasing to 3 ug/L in 2016. Statistical trend analysis indicated a decreasing trend in DCF02-42 and no trend in DCF06-25.

There were no exceedances of the MCL for *cis*-1,2-DCE. Concentrations of *cis*-1,2-DCE in DCF02-42 decreased from 2.7 ug/L in 2015 to non-detect in 2016. Concentrations of *cis*-1,2-DCE in DCF06-25 decreased from 8.5 ug/L in 2013 to 3.9 ug/L in 2016. Statistical trend analysis indicated a decreasing trend in DCF02-42 and no trend in DCF06-25.

VC was detected in DCF02-42 at 0.29 ug/L in 2012, with no detections in 2015 or 2016. There were no detections of VC in DCF06-25 during the five year review period.

Downgradient Area

Two wells are used to monitor groundwater downgradient of the treatment area: DCF02-46A and DCF02-46C. There were no exceedances of MCLs for VOCs in the downgradient wells. PCE in DCF02-46A decreased from 3.9 ug/L in 2012 to 0.33 ug/L in 2016. Statistical trend analysis indicated no trend for PCE in either well.

There were no detections of TCE in DCF02-46C between 2012 and 2016. Concentrations of TCE in DCF02-46A were detected at 0.80 ug/L, 1.2 ug/L, and 0.89 ug/L in 2012, 2013, and 2016, respectively. Statistical trend analysis indicated a decreasing trend for TCE in DCF02-46A. There were no detections of *cis*-1,2-DCE or VC in the downgradient wells between 2012 and 2016.

Time series plots and a "best-fit" line were generated using the output from the Mann Kendall analysis. Select plots for wells with detections of COCs since 2012 are provided in Appendix G.

3.6 Technical Assessment

The objective of the FYR is to evaluate if the remedial action at OU003 is protective of human health and the environment. The technical assessment of the protectiveness of the remedy is based on the responses to the following three questions:

Question A: *Is the remedy functioning as intended by the decision documents?*

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

Question C: *Has any other information come to light that could question the protectiveness of the remedy?*

Question A: Is the remedy functioning as intended by the decision documents?

The answer to Question A is "Yes".

The basis for taking action are the presence of VOCs in the Kansas River alluvial aquifer at levels exceeding drinking water MCLs. The RAOs developed for OU 003 included 1) Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration in groundwater of COCs that exceed cleanup goals, and 2) Achieve cleanup goals of MCLs for COCs in groundwater in the Kansas River alluvium through the use of natural and/or active remedial processes. The selected remedy for OU 003 was MNA with ICs.

Remedial Action Performance and Systems Operations/O&M

Groundwater monitoring data between 2012 and 2016 suggests that MNA continues to be effective in meeting the RAOs for OU 003. The ranges of MNA parameters also indicated favorable conditions for bioremediation. Statistical trend analysis generally indicated decreasing and stable trends for PCE trends across OU 003. An increasing trend was noted in one well located side-gradient from the treatment area at AOCs 1 and 2. The trend may be an indication that PCE has migrated from the potential source area. However, the source area has been remediated and the PCE trend is likely to reverse in time. Increasing trends for *cis*-1,2-DCE and VC were noted in one well in the source area in AOCs 1 and 2. The increase in breakdown products is expected where MNA is occurring.

In 2015, a bench-scale microcosm study was conducted at OU 003 to determine whether biodegradation using native microorganisms to address PCE could be stimulated *in situ*. The report concluded that biodegradation is occurring. Although biodegradation could be enhanced by stimulation with soybean oil emulsion, Fort Riley concluded that further treatment was not warranted based on physical site conditions and access limitations at source areas.

Although MNA appears to be occurring at OU 003, concentrations of COCs still currently exceed MCLs in several wells. According to Fort Riley PWE personnel, groundwater monitoring will continue in accordance with the RD/RA work plan.

Implementation of Institutional Controls

ICs have been implemented and maintained at OU 003 through the 2006 RPMP and 2011 LTMCP. In 2015, a LUCIP was also prepared to ensure that current and future activities are compatible with land use restrictions. The LUCIP identifies several processes that ensure the LUCs remain effective at OU 003. The “Site Approval Process” establishes processes for reviewing and approving excavation and construction projects, as well as other land use changes on the installation. Based on interviews with Fort Riley Environmental Personnel, this process is being followed as part of the installation’s compliance with the NEPA. The Fort Riley NEPA Coordinator provides proposals for projects that could impact IRP sites, including OU 003, to the Environmental Division for review. A review of the procedures for monitoring and enforcement indicated that the Fort Riley O&M program is effective in prevent unacceptable exposure to groundwater and vapor intrusion.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

The answer to Question B is “Yes”.

The fourth FYR process included a review of the screening criteria, toxicity data, exposure assumptions, and remedial action objectives that were used at the time of the remedy selection. The primary objective of this review is to evaluate if these data, criteria, assumptions, and objectives are still protective of human health and the environment.

Exposure Assumptions: There have been no changes in land use or physical conditions since the ROD for OU 003 was approved in 2008. OU 003 was designated as “Open Space” in the RPMP, and restricted activities include building construction, digging and trenching, and drilling drinking water wells. There are no structures on OU 003. As a result, there is no pathway for exposure to groundwater or vapors intrusion and no expectation that exposure will occur in the future.

Screening Criteria and Toxicity Data: Chemical-specific standards established in the ROD for COCs were MCLs that have not changed since the ROD was approved. Because the MCLs were used as screening values for the risk assessment, changes in the risk-based screening levels would not affect the choice of CoCs, the conclusions of the risk assessment, or the protectiveness of the remedy.

Toxicity data was reviewed for groundwater to determine if changes since the ROD could affect the protectiveness of the remedy. Toxicity data for numerous chemicals have changed since 2006, including PCE, TCE, and Benzene, which were detected in groundwater since the previous FYR. Prior to 2009, PRGs and MCLs were used as the source of risk-based screening criteria to identify COCs. Since completion of the RI, the PRGs have been renamed as the RSLs. Underlying toxicity data to evaluate risk include slope factors used to evaluate cancer effects from oral and dermal exposure, inhalation unit risk values used to evaluate cancer effects from inhalation, reference doses used to evaluate non-cancer hazards from oral and dermal exposure, and reference concentrations used to evaluate non-cancer hazards from inhalation. Toxicity data have changed for numerous chemicals, including PCE, TCE, *cis*-1,2-DCE and VC, which were detected in groundwater between 2012 and 2016. The reference doses are now lower for PCE, TCE, *cis*-1,2-DCE and the chemicals are therefore considered more toxic via direct contact routes. Because the current remedy prohibits use of groundwater, and there are no structures at OU 003, the remedy is expected to remain protective until COCs are remediated to MCLs.

ARARS and TBC Criteria: The ROD identified the principal ARARs that are relevant and appropriate for OU 003, as MCLs. The ROD also identified action- and location-specific standards such as endangered and/or threatened species, floodplain, historical, and RCRA requirements that have not changed.

Question C: Has any other information come to light that could question the protectiveness of the remedy?

The answer to Question C is “No”.

No other information has come to light that could call into question the protectiveness of the remedy.

3.7 Technical Assessment Summary

Based on review of documents, interviews, and site inspection, the remedy has been implemented and is functioning as intended by the decision documents. The selected remedy for OU 003, Dry Cleaning Facilities Area, was MNA with ICs. The objective of the remedy was to prevent further degradation of groundwater and potential future exposure to contaminated groundwater until concentrations of COCs meet drinking water MCLs.

Groundwater monitoring data indicated favorable MNA parameters for biodegradation. Decreasing or stable trends of PCE were observed in groundwater in the source area wells. Numerical remediation goals have not been met. However, preventing further degradation of groundwater was accomplished by remediation of soils and groundwater during the initial response. Wells with increasing, stable, or no contaminant trends, are expected to reverse over time.

The remedy is currently protective because implementation and enforcement of ICs prevents unacceptable exposure to groundwater with concentrations exceeding MCLs by restricting residential development, drilling, and installation of water wells. In addition, the remedy is expected to continue to be protective in the future with continued monitoring of COCs and enforcement of ICs.

3.8 Issues

There were no issues found affecting protectiveness of the remedy.

3.9 Recommendations and Follow-Up Actions

No issues that could affect current and/or future protectiveness have been identified for OU 003. Therefore, no follow-up actions are required at this time.

3.10 Protectiveness Statement

The remedy for OU 003, Dry Cleaning Facilities Area, is protective of human health and the environment.

The remedy, which consists of MNA with ICs, remains protective by:

- Monitoring groundwater to ensure that biodegradation continues to effectively reduce concentrations of COCs and eventually meet remediation goals; and

- Preventing exposure to groundwater with enforcement of ICs that prohibit drilling and installation of water wells.

4.0 354 Area Solvent Detections, OU 005

Table 4.1 Chronology of Key Events at OU 005

Event	Date
Building 354 constructed as a gasoline service station	1935
The 354 site formally designated an operable unit after soil and groundwater investigation undertaken after underground storage tank removals reveals the presence of chlorinated solvents	January 1997
RI/FS Work Plan	February 1999
RI Field Work	June 1999 - July 2000
Field Data Evaluation Addendum	January 2001
Additional RI Field Work	May - November 2001
354 Air Sampling Plan	December 2002
Air Sampling 354 Area Solvent Detections Work Plan	February 2003
Phase 1 Air Sampling	February 2003 - April 2004
Phase 2 Air Sampling	April - June 2003
RI Report	November 2003
Pilot Study Work Plan	December 2003
Pilot Study Field Work	March 2004 - February 2005
Soil Gas Investigation Work Plan and Field Work	September 2004 - January 2005
Feasibility Study Report	December 2004
Proposed Plan	May 2005
Soil Gas Investigation Report	June 2005
Pilot Study Report	June 2005
Record of Decision	June 2006
Remedial Design/Remedial Action Plan Approved	April 2007
First Five-Year Review of OU005	September 2007
Second Five-Year Review of OU005	September 2012
Increasing concentrations of PCE in three monitoring wells	March, July 2014
Explanation of Significant Difference	March 2015
Final Work Plan for Pre-Design Investigation	April 2016
Pre-Design Investigation	April-May 2016

4.2 Background

4.2.1 Summary

OU 005, 354 Area Solvent Detections, is located at the Main Post cantonment area north of the Kansas River. The Site currently encompasses portions of the Main Post as far north as Godfrey Avenue, and most of the point bar of the Kansas River south of the UPRR and east of the Henry Drive Bridge (Figure 4-1). The site is characterized by a VOC plume consisting primarily of PCE, TCE, and benzene, in groundwater.

4.2.2 Physical Characteristics

A point bar and an ancient alluvial terrace dominate the topography in this area. The point bar is part of the active floodplain and consists of approximately 60 feet of alluvial sediments overlying shale or limestone bedrock. The terrace, located north of the railroad grade, also consists of alluvial sediments deposited on shale and limestone bedrock. However, this area is topographically higher than the floodplain and the unconsolidated terrace deposits vary in thickness from 9 to 64 feet.

4.2.3 Land and Resource Use

North and west of the UPRR grade is a developed area (Main Post) with building and road development. Buildings include offices, barracks, family housing units, warehouses, and maintenance facilities. South and east of the UPRR grade is the point bar of the Kansas River. This area is mainly covered with forest and vegetation. There is one developed area between the UPRR grade and Marshall Avenue that consists of warehouses, several of which have been converted to office buildings (Figure 4-2).

Land use at OU 005 is classified under multiple land use designations in the RPMP, including open space, industrial, maintenance, supply/storage, and administration. It is anticipated that land use activities will remain unchanged into the foreseeable future. The Main Post area to the north of the UPRR grade is classified as a National Register Historic District. The area to the south of the UPRR grade is classified as "Open Space" in the RPMP. This classification is not expected to change because it is within the active flood plain of the Kansas River where land use must be in compliance with Executive Order 11988 – Floodplain Management. Army Regulations 200-2 furthermore require legal adherence to the Executive Order. This Order restricts and places requirements on actions that occur within a flood plain. Additionally, the area within 100 meters of the current Kansas River bank is wildlife habitat for bald eagles that winter at Fort Riley.

Fort Riley has eight active wells in the Republican River alluvial aquifer. The Fort Riley water supply wells are located approximately four miles upgradient (west) of OU 005.

4.2.4 History of Contamination

The former Building 354 was constructed in 1935 as a gasoline service station. Following the removal of underground storage tanks (USTs) at the Building 354, investigation of soil and groundwater revealed the presence of chlorinated solvent contamination in groundwater, primarily PCE. As a result, the 354 Area Solvent Detections was formally designated as an OU in January 1997.

The major findings of a 2004 RI were that soil and groundwater were media of concern. The additional investigation indicated that the primary source of PCE was not Building 354, but was in fact, associated with activities in Building 367. Building 367 is located approximately 1,200 feet upgradient (north) of Building 354. Building 367 was constructed in 1903 and originally served as an artillery gun shed. It was later used for storage and some limited small vehicle maintenance. It is on the National Register of Historic Places as part of the Main Post Historic District.

4.2.5 Initial Response

A 2004 soil remediation performed at the Building 367 location included treatment with an *in-situ* mixing of potassium permanganate to oxidize the chlorinated solvents present. At that time, the soil mixture remained too wet and was subsequently removed to a land-farm cell where it was dried, tilled, and tested until the PCE tested below the regulatory standard (180 ug/kg). The excavation was backfilled with clean soil and the site re-paved with 8" of asphalt. Approximately 1,000 cubic yards of chlorinated solvents-contaminated soil were remediated at Building 367.

4.2.6 Basis for Taking Action

The basis for taking action at OU 005 was the unacceptable risk associated with potential future use of groundwater as a drinking water source. Drinking water standards (MCLs) were considered relevant and appropriate as cleanup levels. Four VOCs (PCE, TCE, *cis*-1,2-DCE, and benzene) exceeded the drinking water MCLs.

4.3 Remedial Actions

4.3.1 Remedial Action Objectives

The ROD for OU 005 was approved on 16 June 2006. The RAOs identified in the ROD were:

- Prevent the potential for degradation of the surface waters of the Kansas River by reducing levels or eliminating contaminants from the margin of the Kansas River alluvial aquifer;

- Reduce contamination levels to below MCLs within the Kansas River alluvial aquifer through use of natural and/or active remedial processes; and

- Reduce contaminant levels, to the extent practicable and appropriate, within the terrace aquifer, through natural and/or active remedial processes.

4.3.2 Remedy Selection

The selected remedy for OU 005 was MNA with ICs. Specifically, the remedy included groundwater monitoring and restricting residential land use, limiting public access, and prohibiting use of groundwater.

The selected remedy was to be considered complete, per Section 2.13.6 of the ROD that stated, "*if no wells exceed groundwater cleanup levels (MCLs) for three consecutive years in the Kansas River alluvial aquifer, a recommendation for discontinuing sampling and site closure will be made*."

The numerical cleanup goals established in the ROD were MCLs for the site COCs:

• PCE	5 µg/L
• TCE	5 µg/L
• *cis*-1,2-DCE	70 µg/L
• Benzene	5 µg/L

The ROD was modified in March 2016 by an Explanation of Significant Difference (ESD) following an increase in PCE concentrations during sampling events in March and April 2014. Based on that data, it was determined that continuing with the passive MNA remedy would result in ineffective PCE treatment of terrace groundwater that could eventually impact downgradient wells. The Summary of Basis presented in the ESD stated:

> *The changed remedy will consist of in situ bioremediation of the soil and ground water in the upland terrace materials at the site followed by MNA in the terrace and alluvial aquifers in order to monitor remedial progress. In situ bioremediation will consist of injections of a carbon donor substrate in order to create a reducing environment in the subsurface that will promote anaerobic degradation of the PCE contamination by naturally-occurring microbial populations in the subsurface.*
>
> *A potential course of action is to install a line of GeoProbe© injections with overlapping radii of influence up gradient and down gradient of each of the three terrace monitoring wells. The injections will be from just below the surface of the soil to the top of the ground water level. A substance such as emulsified soybean oil will be injected into the soil to ground water zone in order to enhance soil microbial activity. This proposed change is expected to result in the increased destruction of the PCE and its daughter products within the terrace aquifer.*

4.3.3 Remedy Implementation

Monitoring wells were sampled annually from 2006 through 2009. Additional sampling events were completed in August 2011, April 2012, March and July 2014, and July 2016 as a component of the remedy specified in the ROD. Groundwater was also sampled in May, August, and November, 2016 as part of the Pre-Design Investigation (PDI) to evaluate *in-situ* remedial technologies as a component of the modified remedy specified in the ESD to the ROD. Groundwater was sampled for VOCs and MNA parameters of temperature, pH, DO, ORP, MEE, alkalinity, chloride, nitrate, sulfate, sulfide, total organic carbon, and ferrous iron.

Fort Riley ICs are documented in the RPMP and include restricting land use to non-residential, limiting public access, and prohibiting installation of drinking water wells and groundwater use at OU 005. The LUCIP report dated October 2015 indicated that LUCs at OU 005 were functioning as intended in accordance with the ROD and that no new LUCs were planned for the site.

A contract was awarded in September 2015 to conduct a PDI to determine if there were any persistent sources of residual PCE contamination present in vadose zone soils near the former source area that might be contributing to increasing groundwater contaminant levels observed in 2014. The Final Work Plan for the PDI was completed in April 2016. It included a direct-push soil investigation to determine if any remaining source of PCE is present in vadose zone soil near the original source area (Building 367) and to refine the nature and extent of PCE contamination.

Field activities for the PDI included the sampling of soil and groundwater using direct-push sampling equipment, two rounds of groundwater sampling using low flow protocols at seven on-site monitoring wells, and the management of IDW. A total of 79 soil and groundwater borings were advanced in the vicinity and down-gradient of the 354 Area site in April and May 2016, using direct-push sampling equipment. At 10 direct-push boring locations, both soil and groundwater samples were collected. The remaining 69 direct-push boring locations were advanced to bedrock refusal to collect groundwater samples. Soil and groundwater samples were submitted to the on-site field GC for analysis of TCE, PCE, cis-1,2 DCE. Confirmation soil and groundwater samples were shipped for off-site laboratory analysis at a rate of approximately 10 percent. Soil samples were submitted to the off-site laboratory for analysis of VOCs, manganese, Total Organic Carbon, Acid Volatile Sulfides (AVS), and Bioavailable Ferric Iron (BAI). Groundwater samples were submitted to the off-site laboratory for analysis of VOCs and MEE.

As part of the PDI, groundwater monitoring activities to determine the current groundwater geochemical conditions and potential remediation actions were also conducted May, August 2016, and November 2016.

The results of the PDI are presented in the *Final Pre-Design Investigation Report* (June 2017). The report concluded that that direct-push soil sample results from both the field GC and off-site laboratory indicated that concentrations of PCE, TCE, and cis-1,2 DCE were well below their Project Action Limits (PALs) and that there did not appear to be a secondary source area in vadose zone soils. Based on the findings, the report concluded that additional investigation and remediation to soils at OU 005 did not appear to be warranted. Direct-push groundwater results from both the field GC and off-site laboratory indicated that groundwater concentrations of PCE and TCE exceeded their PALs south of the source area and extending down gradient. The extent of PCE and TCE contamination was bound by direct-push groundwater borings with detections below the PALs, non-detections, or no groundwater encountered.

The PDI report recommended completion of the remaining rounds of quarterly groundwater sampling. Three potential long-term recommendation scenarios were proposed if after the completion of quarterly monitoring for two years (eight events), contaminant concentrations did not show a downward trend to near or below their April 2012 levels, or contaminant concentrations increased again. These included continued groundwater sampling and potential *in-situ* chemical oxidation (ISCO) injection using a chemical substrate such as potassium or sodium permanganate.

4.3.4 Operation and Maintenance

Operation and maintenance activities are limited to annual monitoring and reporting. Costs associated with these activities are provided in Table 4-2. O&M costs are associated with annual monitoring and reporting.

Groundwater monitoring data have been collected at OU 005 since 2000. Analytical results are discussed in Section 4.5.3.

Table 4-2
OU 005 Annual O&M Costs

Fiscal Year	Total Cost
2013	$19,674
2014	$18,099
2015	Not Provided
2016	$16,510

4.4 Progress since the Last Five-Year Review

The issues and recommendations and status identified in the previous FYR that affected current and future protectiveness are presented in Table 4-3. Groundwater monitoring events were conducted in 2014 and 2016 since the previous FYR. In addition, groundwater was sampled in May, August, and November 2016 as part of the PDI effort. The evaluation of groundwater water monitoring data since the previous FYR is discussed in Section 4.5.3.

Table 4-3
Progress since the Last Five-Year Review

Issue	Recommendation	Follow-Up	Status
Comparison of soil vapor data at OU 005 to current screening values in accordance with the most recent guidance (EPA 2002) for vapor intrusion suggests that there is a potential risk from vapor intrusion at Building 367.	Prepare a Technical Memorandum for EPA review and approval to specify all site conditions and procedures that must be in place to mitigate potential vapor intrusion exposure. The document should include all site history, investigation data, and site use information necessary to support the effectiveness of mitigation.	A Technical Memorandum was prepared in response to the issues identified in the 2012 FYR as an Addendum to the 2012 FYR.	Complete

ICs related to vapor intrusion at OU 005 are described in a letter to the USEPA; however, these ICs are not currently included in the LUCIP.	If it is confirmed that ICs are required, update the LUCP to include the IC requirements contained in the letter to the USEPA, and ensure that the ICs are modified, implemented and updated as appropriate.	Based on the conclusions of the Technical Memorandum, no additional ICs are required for OU 005.	Complete

The Technical Memorandum is provided in Appendix H. The Technical Memorandum presented the condition and history of the structure potentially impacted by impacted soil and groundwater at OU 005, the results of the human health risk assessment, indoor air sampling, soil-gas investigation, and discussion of risk. Based on the data, such as the physical setting at the site with regard to the building, its structure and conditions, the 8-inch thick pavement, soil characteristics, and the removal of the contaminated soils, a complete vapor intrusion pathway was not considered feasible. The Technical Memorandum concluded that vapor intrusion exposures in the building did not present a potentially significant threat to human health and that warning signs of potential vapor intrusion and directions to avoid potential exposure were sufficient to ensure protectiveness of human health.

4.5 Five-Year Review Process

4.5.1 Site Inspection and Interviews

The Fort Riley IRP Manager provided an overview of activities and identified the wells that are monitored as part of the groundwater monitoring program for OU 005. The wells appeared to be secured and in good condition. He noted that the increase in concentrations of PCE in monitoring wells in 2014 appeared to be associated with horizontal drilling apparently used to install a water line adjacent to one of the wells. The large volume of water used during drilling resulted in mobilization of residual concentrations of PCE that were detected in 2014. He also noted that concentrations appeared to be attenuating based on sampling in 2016.

The USEPA Remedial Project Manager reported that his overall impression of the environmental program for OU 005 was good and that he was kept well informed about the activities and progress related to the site. The KDHE Project Manager reported that her overall impression of the environmental program for OU 005 was positive and that she was kept informed about the activities and progress by participating in quarterly meetings.

4.5.2 Document Review

The Five-Year Review process consists of a review of relevant project documents, including annual monitoring reports, technical reports, and operation and maintenance reports. Documents reviewed for OU 005 for this FYR included (in chronological order) included:

- Burns & McDonnell, 2006, *Record of Decision 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas, June 2006*;
- Black & Veach, 2007, *Real Property Master Plan Digest, Fort Riley, Kansas.* August;
- Fort Riley, 2012, *Third Five-Year Review Report, Fort Riley, Junction City, Geary, Clay and Riley Counties, Kansas.* September;
- Fort Riley, 2012, *Addendum to the Third Five-Year Review Report for Fort Riley, Kansas dated 27 September 2012;*
- Fort Riley, 2105, *Explanation of Significant Difference for the Record of Decision at the 354 Area Solvent Detections Operable Unit 005, Fort Riley Kansas.* February;
- HydroGeoLogic, Inc., 2015, *2014 Annual Long-Term Monitoring Report, 354 Area Solvent Detections OU 005 (FTRI-031), Fort Riley, Kansas.* April 2016;
- Aerostar SES LLC, 2015, *Land Use Control Implementation Plan, Fort Riley, Kansas.* October;
- HydroGeoLogic, Inc., Draft *2016 Annual Long-Term Monitoring Report, 354 Area Solvent Detections OU 005 (FTRI-031), Fort Riley, Kansas.* October;
- Avatar Environmental/Burns & McDonnell, 2017, *Pre-Design Investigation Report, 354 Area-Operable Unit 005, Fort Riley, Kansas,* October;
- Avatar Environmental/Burns & McDonnell, 2017, Quality Control Summary Report for the 354 Area Groundwater Monitoring Event 3, Fort Riley, Kansas, March; and
- USEPA, May 2016, *Regional Screening Levels; and*

4.5.3 Data Review

The Five-Year Review process consists of a review and evaluation of data generated since the previous FYR. Groundwater monitoring data from April 2012 to November 2016 for four MNA monitoring wells are summarized in Table 4-4. Complete groundwater data for 2014 and 2016 are provided in Appendix H. The text, tables, and figures presented in the PDI report are also provided for reference in Appendix H.

The groundwater potentiometric maps for March 2014, May 2016, July 2016, August 2016, and November 2016 are shown in Figures 4-3 through 4-8, respectively. Groundwater flow was consistently to the south toward the Kansas River.

A summary of the analytical results for April 2012 through November 2016 events for the four MNA monitoring wells is provided in Table 4-4. The results indicated a significant increase in PCE between April 2012 and March 2014 in three wells downgradient of Building 367. Concentrations of PCE then decreased and by November 2016 were similar to 2012 levels in wells 354-01-27 and 354-99-09. In TS0292-01, downgradient of Well No. 354-99-09, concentrations also decreased over the five-year period, but still remained elevated compared to levels concentrations measured in 2012. The analytical results for COCs for May and August 2016 collected as part of the PDI are depicted in Figure 4-9, and shows the PCE plume extending from north to south starting in the suspected source are (Building 367) to approximately 300 feet south of the railroad tracks.

The MNA parameters, MEE, ethene, TOC, and sulfide, were also analyzed as part of the groundwater monitoring program. Temperature, pH, DO, and ORP readings were monitored as part of the well purging stabilization process. In 2016, the wells with favorable MNA parameters were the most up-gradient well (354-01-27), and the down-gradient well (TSO292-01). The variation in the PCE concentrations between wells 354-99-09 and TSO292-01 may be an indication of migration of PCE from upgradient areas. The increase of PCE in 2014 appears to have been an isolated event and concentration of PCE in TSO292-01 is likely to continue to decrease, but at a slower rate based on less favorable MNA conditions.

Results of the Mann-Kendall trend analyses using historical data between 2000 and 2016 are summarized in Table 4-5. Worksheets for the trend analysis are provided in Appendix H.

Table 4-4
Summary of Detects 2012-2016

MCL (µg/L)	**354-01-27**		**354-99-09**		**TS0292-01**			**TS0292-02**
	PCE 5	**TCE 5**	**PCE 5**	**TCE 5**	**PCE 5**	**TCE 5**	**Benzene 5**	**Benzene 5**
4/12	**8.9**	ND	**8.1**	**1.0**	**13**	**1.2**	ND	**3.3**
3/14	**94.1**	**1.4**	**33.1**	**0.45 J**	**56.6**	**4.3**	ND	ND
7/14	**80.5**	**1.1**	**27.3**	**0.31**	**50.1**	**4.6**	**0.58 J**	**2.7**
5/16*	**85.0**	**1.0**	**12.0**	ND	**39.0**	**3.1**	ND	ND
7/16	**13.7**	ND	**13.1**	ND	**45.1**	**3.2**	**0.29 J**	**0.62 J**
8/16*	**5.5**	ND	**5.2**	ND	**20.0**	**2.1**	ND	ND
11/16*	**6.6**	ND	**7.8**	ND	**32.0**	ND	ND	ND

MCL = maximum contaminant level
*= results of samples collected as part of the PDI
J = estimated
ND = below detection limit
Bold=Detection exceeds MCL
Shaded cell=result exceeded MCL

Table 4-5
Summary of Concentration Trends for COCs at OU 005

COC	354-01-27	354-99-09	TSO292-01	TSO292-02
Benzene	NA	NA	NT	D
cis-1,2-DCE	NA			
PCE	D	D	PD	NA
TCE	D	D	ND	NA

NA = Mann-Kendall trend not analyzed; insufficient number of detections to perform analysis.
D = decreasing trend I = increasing trend NT = no trend S = stable PD=probably decreasing trend

4.6 Technical Assessment

The objective of the FYR is to evaluate if the remedial action at OU005 is protective of human health and the environment. The technical assessment of the protectiveness of the remedy is based on the responses to the following three questions:

Question A: *Is the remedy functioning as intended by the decision documents?*

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

Question C: *Has any other information come to light that could question the protectiveness of the remedy?*

Question A: Is the remedy functioning as intended by the decision documents?

The answer to Question A is “Yes”.

The basis for taking action was the presence of COCs in groundwater at levels exceeding drinking water MCLs. The RAOs developed for OU 005 included 1) Prevent the potential for degradation of the surface waters of the Kansas River by reducing levels or eliminating contaminants from the margin of the Kansas River alluvial aquifer; 2) Reduce contamination levels to below MCLs within the Kansas River alluvial aquifer through use of natural and/or active remedial processes; and 3) Reduce contaminant levels, to the extent practicable and appropriate, within the terrace aquifer, through natural and/or active remedial processes. The selected remedy for impacted groundwater was MNA with ICs. Following an increase in concentrations of PCE in 2014, an ESD to the ROD in 2015 modified the remedy to include *in-situ* bioremediation of the groundwater plume and quarterly groundwater monitoring for two years.

Remedial Action Performance and Systems Operations/O&M

The remedy identified in the ESD has been initiated, but not fully implemented. A PDI work plan was prepared in support of the remedy proposed in the ESD included investigation of soil and groundwater to refine the nature and extent of PCE contamination and the viability of *in-situ* bioremediation. The PDI was conducted in April and May 2016. The PDI report concluded that there did not appear to be any secondary source of PCE that resulted in the elevated levels of PCE observed in 2014 and that further remediation of soil did not appear warranted. Three of eight proposed quarterly groundwater monitoring events were completed in May, August, and November, 2016. An additional annual groundwater monitoring event was conducted in July 2016. Analytical results indicated a decreasing trend for PCE between 2014 and 2016. There have been no exceedances of MCLs for COCs in the most downgradient LTM well since 2011.

If contaminant concentrations continue to demonstrate a downward trend after completion of remaining quarterly sampling, *in-situ* bioremediation may not be necessary. In this event, a change in the remedy as presented in the ESD should be considered in consultation with pertinent regulatory agencies.

Implementation of Institutional Controls

Institutional controls have been implemented and enforced at OU 005 through the 2006 RPMP and 2011 LTMCP. In 2015, a LUCIP was also prepared to ensure that current and future activities are compatible with land use restrictions. The LUCIP identifies several processes that ensure the ICs remain effective including “Site Approval Process” for reviewing and approving excavation and construction project, as well as other land use changes on the installation. Based on interviews with Fort Riley Environmental Personnel, this process is being followed as part of the installation’s compliance with the NEPA. The Fort Riley NEPA Coordinator provides proposals for projects that could impact IRP sites, including OU 005 to the PWE. Based on the review of documents, interviews and site inspection, the program for monitoring enforcement of ICs at OU 005 is effective and ensures protectiveness by preventing exposure to groundwater. Continued enforcement of ICs is expected to maintain protectiveness until concentrations of COCs are reduced to their respective MCLs.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

The answer to Question B is “Yes”.

The fourth FYR process included a review of the screening criteria, toxicity data, exposure assumptions, and remedial action objectives that were used at the time of the remedy selection. The primary objective of this review is to evaluate if these data, criteria, assumptions, and objectives are still protective of human health and the environment.

Exposure Assumptions: There have been no changes in land use or physical conditions since the ROD for OU 005 was approved in 2006. The RPMP restricts drilling water wells. As a result, there is no complete pathway for exposure to groundwater, and there is no expectation that exposure will occur in the future.

Screening Criteria and Toxicity Data: Chemical-specific standards established in the ROD for COCs were Federal MCLs, which have not changed since the ROD was approved. Because the MCLs were used as screening values for the risk assessment, changes in the risk-based screening levels for several COCs would not affect the choice of COCs, the conclusions of the risk assessment, or the protectiveness of the remedy.

Toxicity data was reviewed for groundwater to determine if changes since the ROD could affect the protectiveness of the remedy. Toxicity data for numerous chemicals have changed since 2006, including PCE, TCE, and Benzene, which were detected in groundwater since the previous FYR. Prior to 2009, PRGs and MCLs were used as the source of risk-based screening criteria to identify COCs. Since completion of the RI, the PRGs have been renamed as the RSLs. Underlying toxicity data to evaluate risk include slope factors used to evaluate cancer effects from oral and dermal exposure, inhalation unit risk values used to evaluate cancer effects from inhalation, reference doses used to evaluate non-cancer hazards from oral and dermal exposure, and reference concentrations used to evaluate non-cancer hazards from inhalation. Toxicity data have changed for numerous chemicals, including PCE, TCE, and benzene, which were detected in groundwater between 2012 and 2016. A comparison of change in toxicity data indicated that the reference dose is now higher for benzene and therefore benzene is considered less toxic via direct contact routes. The reference dose is now lower for PCE and therefore PCE is considered more toxic via direct contact routes. Because the current remedy prohibits use of groundwater, and thus potential ingestion or dermal contact, the remedy would still be protective.

The VI pathway for Building 367 was evaluated as part of the baseline risk assessment in 2003. The evaluation concluded that there was no unacceptable VI risk. The previous FYR recommended that this pathway be re-evaluated based on changes in screening levels and toxicity data. The results of the evaluation using 2011 toxicity values were presented in a Technical Memorandum as an addendum to the Third FYR. As discussed in Section 4.4, the evaluation concluded that there was no unacceptable VI risk based on the results for soil, groundwater, soil-gas, and indoor air testing during the RI, removal of the source, exposure scenarios, and physical construction of the building. The inhalation unit risk value for TCE is higher and is TCE is now considered a more potent carcinogen via the inhalation pathway. The inhalation unit risk value is now lower for PCE and benzene. The VI pathway was evaluated using November 2016 monitoring data, the VISL calculator, and 2016 toxicity data for indoor-air. The evaluation indicated no unacceptable risk for indoor air for commercial land use. The worksheets are included in Appendix H.

ARARS and TBC Criteria: The ROD identified MCLs as the principal ARARs that are relevant and appropriate for OU 005. The ROD also identified action- and location-specific standards, such as endangered and/or threatened species, floodplain, historical, and RCRA requirements, which have not changed.

Question C: Has any other information come to light that could question the protectiveness of the remedy?

The answer to Question C is “No”.

No other information has come to light that could call into question the protectiveness of the remedy.

4.7 Technical Assessment Summary

The selected remedy in the 2006 ROD for OU 005 was MNA with ICs. The objective of the remedy was to prevent further degradation of groundwater and exposure to contaminated groundwater until concentrations of COCs met drinking water MCLs. The remedy was subsequently modified in March 2016 following a significant increase in PCE concentrations in groundwater in 2014. The revised remedy included a PDI to identify other potential sources of PCE and evaluation of *in-situ* bioremediation technologies. The revised remedy has not been fully implemented.

Based on the review of documents, interviews, and site inspection, the remedy is currently protective because Fort Riley has implemented and enforces ICs that include restriction of residential development and drilling and installation of water wells. The RG for COCs at OU 005 have not been met. However, implementation of the revised remedy, continued groundwater monitoring, and continued enforcement of ICs will ensure that the remedy remains protective until concentrations of COCs meet RGs.

4.8 Issues

There were no issues identified during the FYR affecting the protectiveness of the remedy.

4.9 Recommendations and Follow-up Actions

No issues that could affect current and/or future protectiveness were identified for OU 005. Therefore, no follow-up actions are required at this time.

4.10 Protectiveness Statement

The remedy at OU 005, 354 Area Solvent Detections, is expected to be protective of human health and the environment upon completion of the remedy as described in the 2016 ESD. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

5.0 Next Review

The next FYR for Fort Riley is required no later than five years from the completion date of this report.

FIGURES

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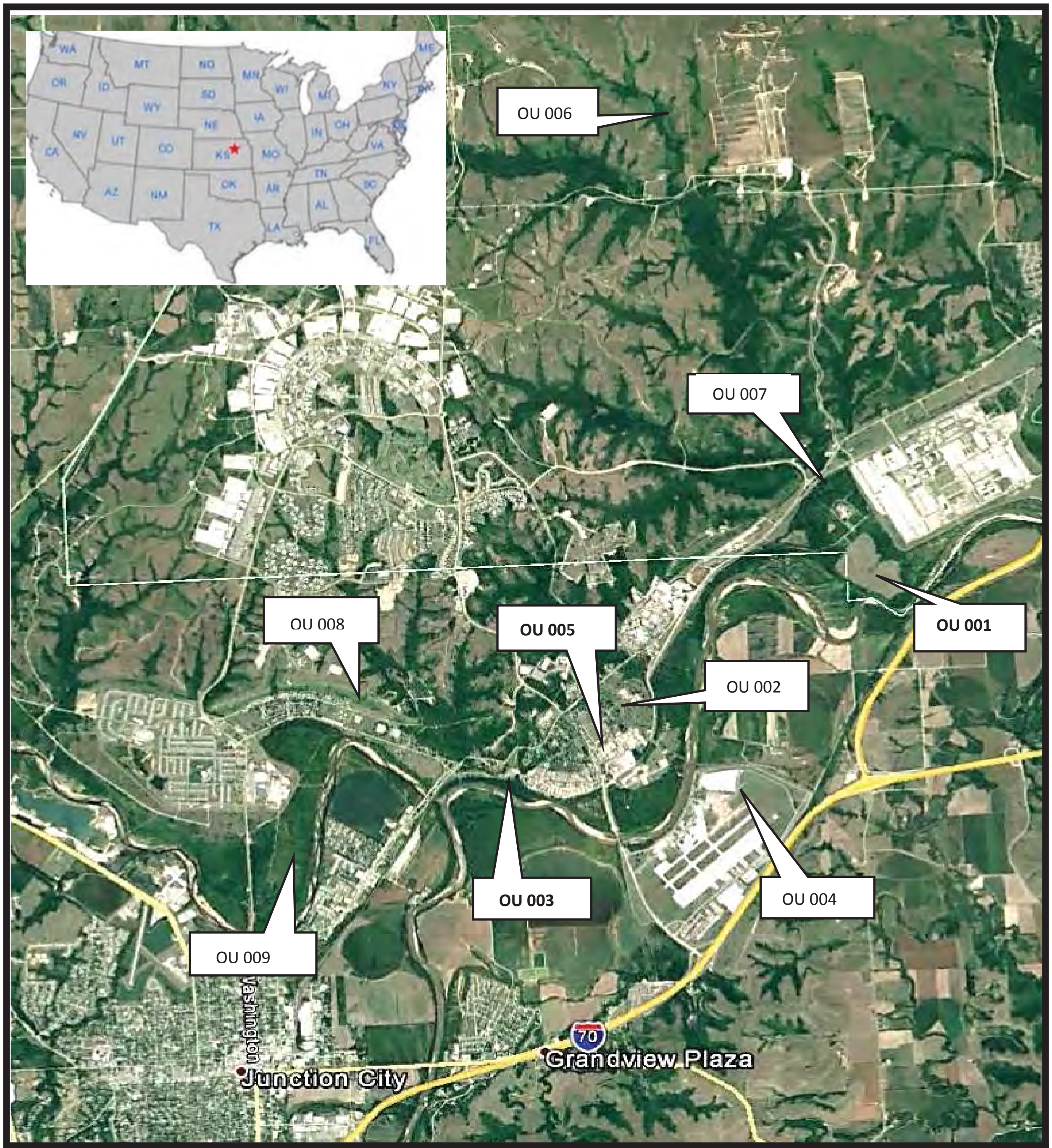

Figure 1-1
Approximate Location of Operable Units at Fort Riley, Kansas

OU-001 - South Funston Landfill
OU 002- Pesticide Storage Facility
OU 003 - Dry Cleaning Facilities Area
OU 004 - FFTA, Marshall Army Airfield
OU 005 - 354 Area Solvent Detections Area
OU 006 – OB/OD, Range 16
OU 007 – Camp Funston Incinerator
OU 008 - Sherman Heights Small Arms
OU 009 – Camp Forsyth Landfill

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OPERABLE UNIT 001
SOUTHWEST FUNSTON LANDFILL

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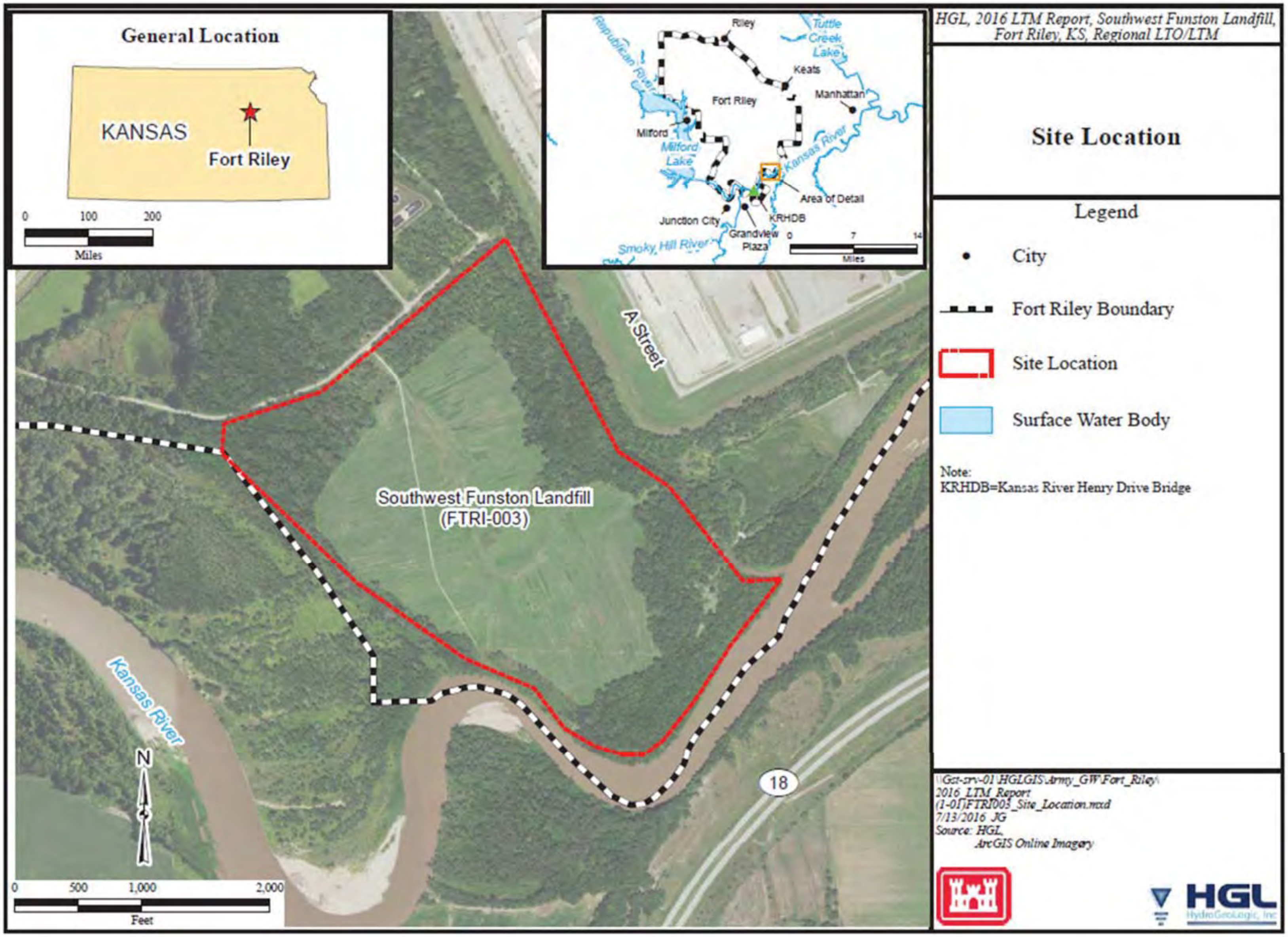


Figure 2-1. Location and Site Layout of OU 001

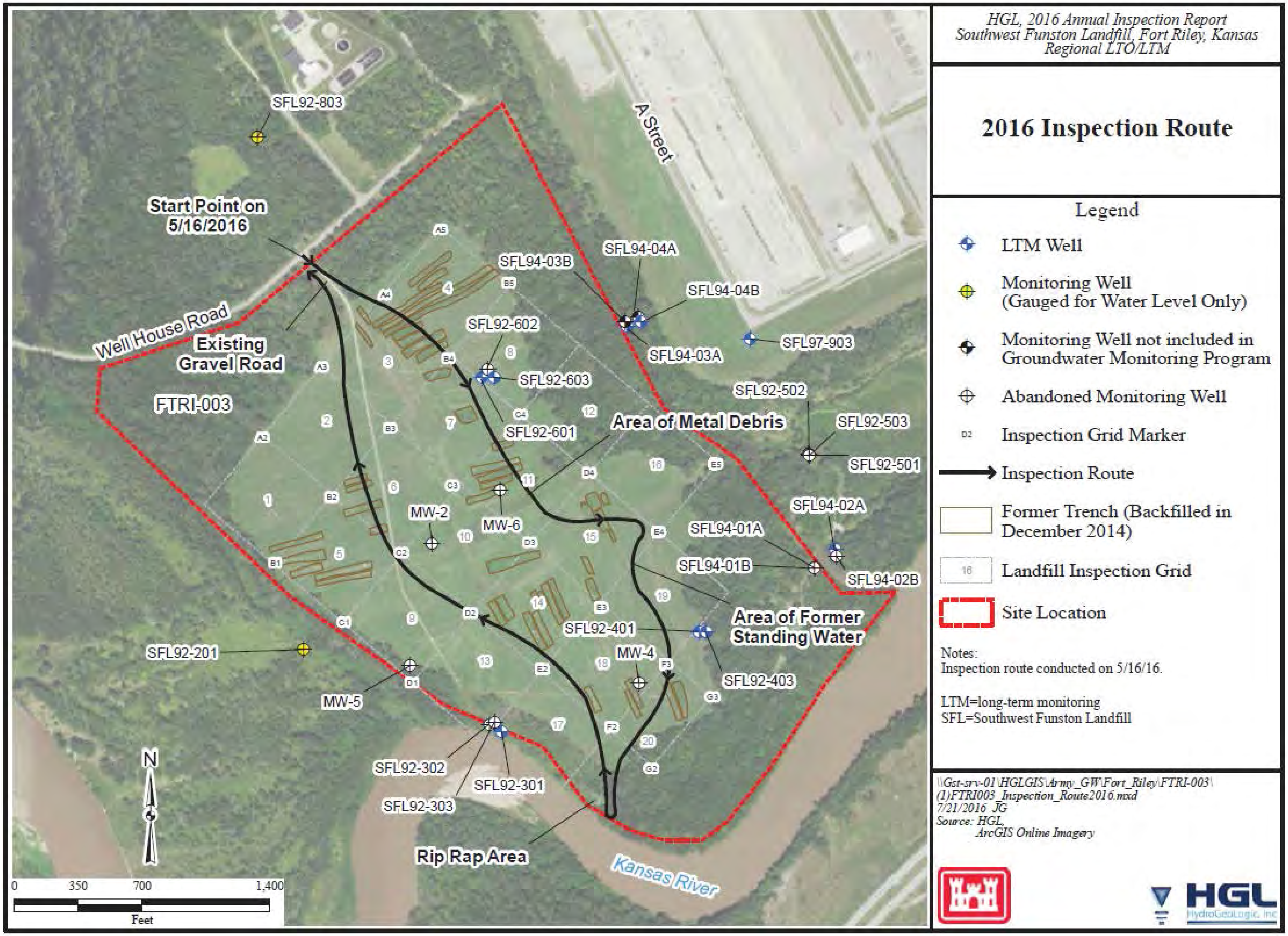


Figure 2-2. 2016 Site Inspection Route

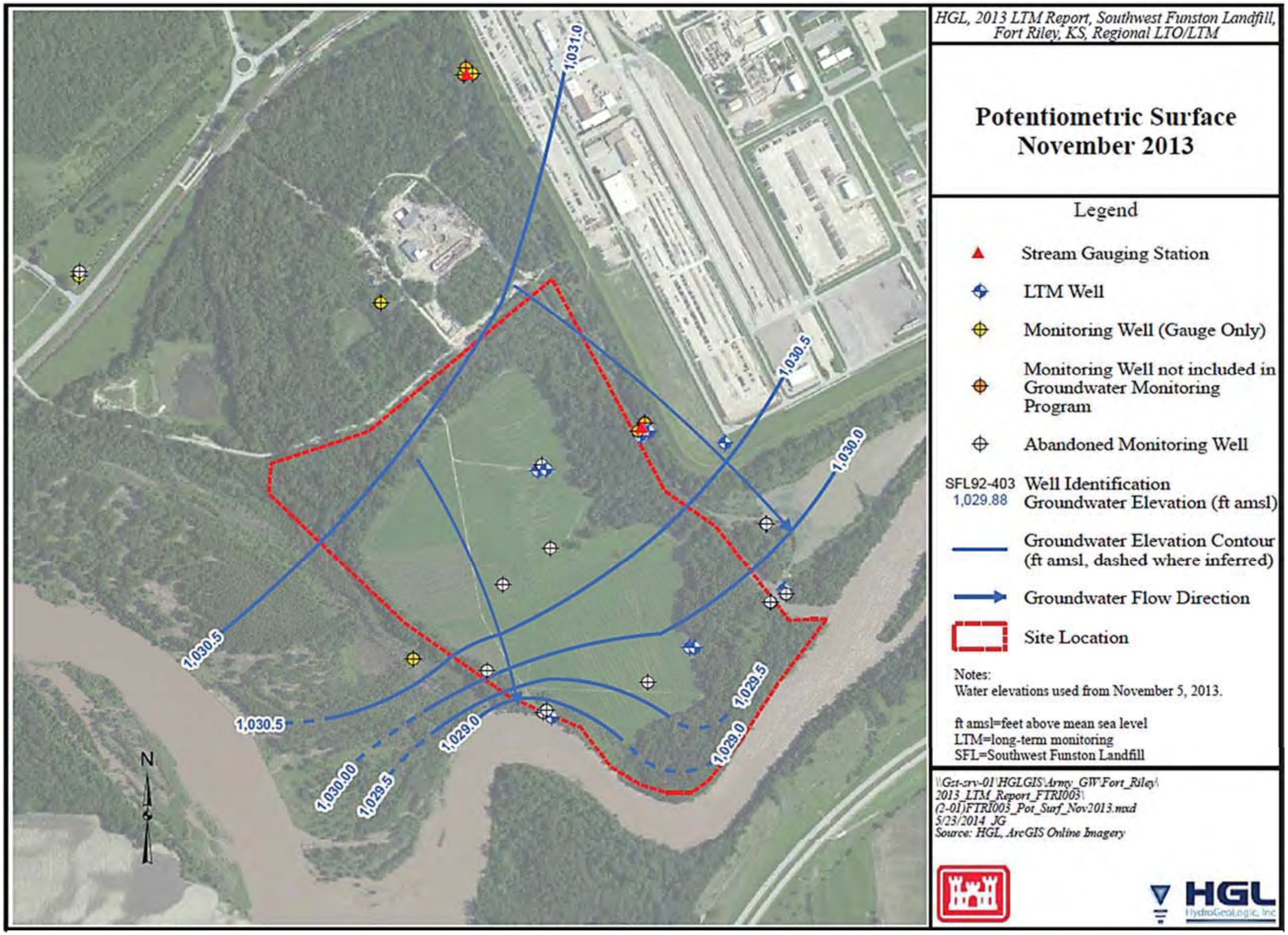
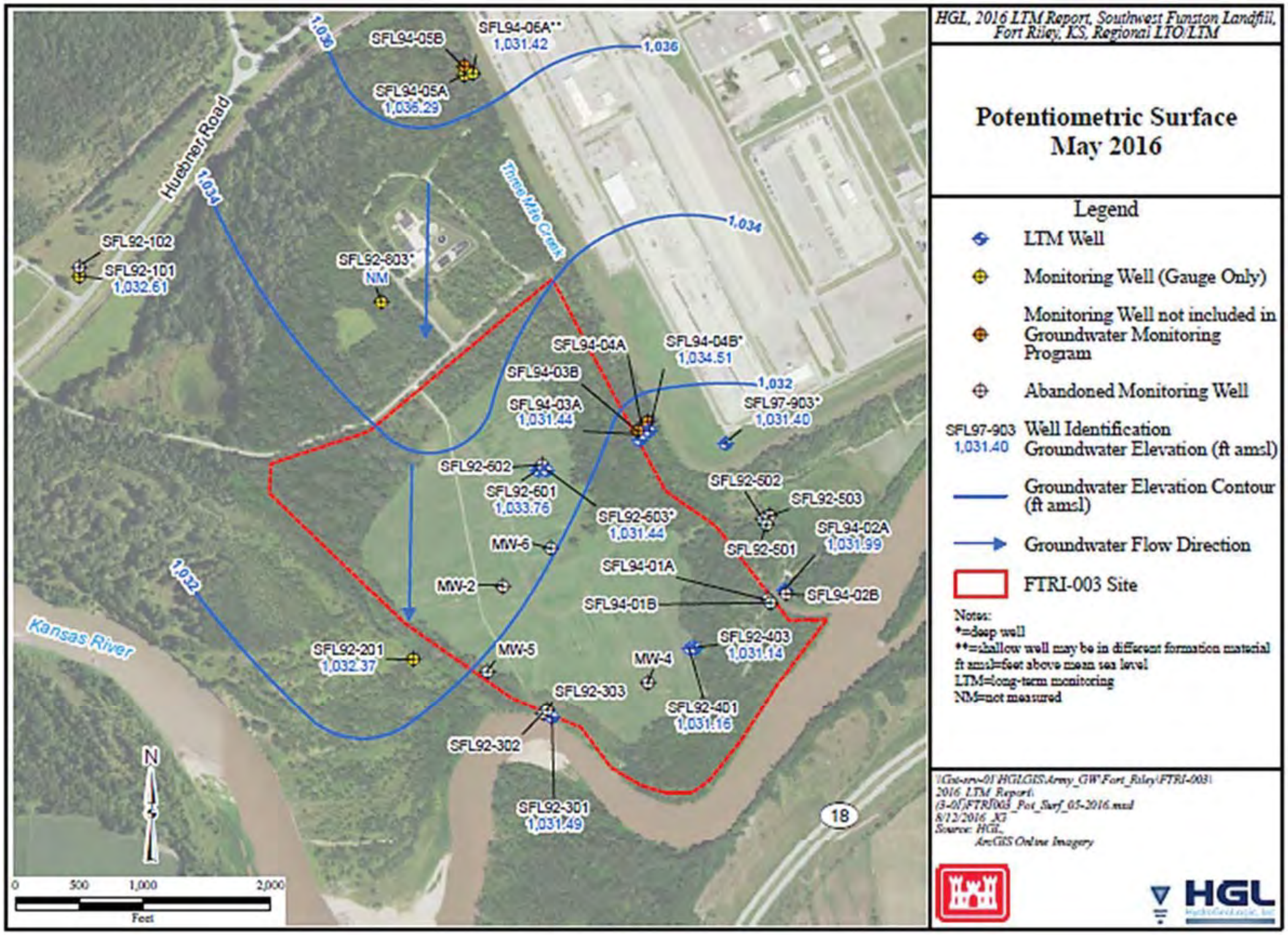


Figure 2-3. Groundwater Potentiometric Surface Map, OU 001, 2013



HGL, 2016 LTM Report, Southwest Funston Landfill, Fort Riley, KS, Regional LTO/LTM

Potentiometric Surface
May 2016

Notes:
*=deep well
**=shallow well may be in different formation material
ft amsl=feet above mean sea level
LTM=long-term monitoring
NM=not measured

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2016_LTM_Report
(3-07)FTRI003_Pot_Surf_05-2016.mxd
8/12/2016_XJ
Source: HGL,
ArcGIS Online Imagery

Figure 2-4. Groundwater Potentiometric Surface Map, OU 001, 2016

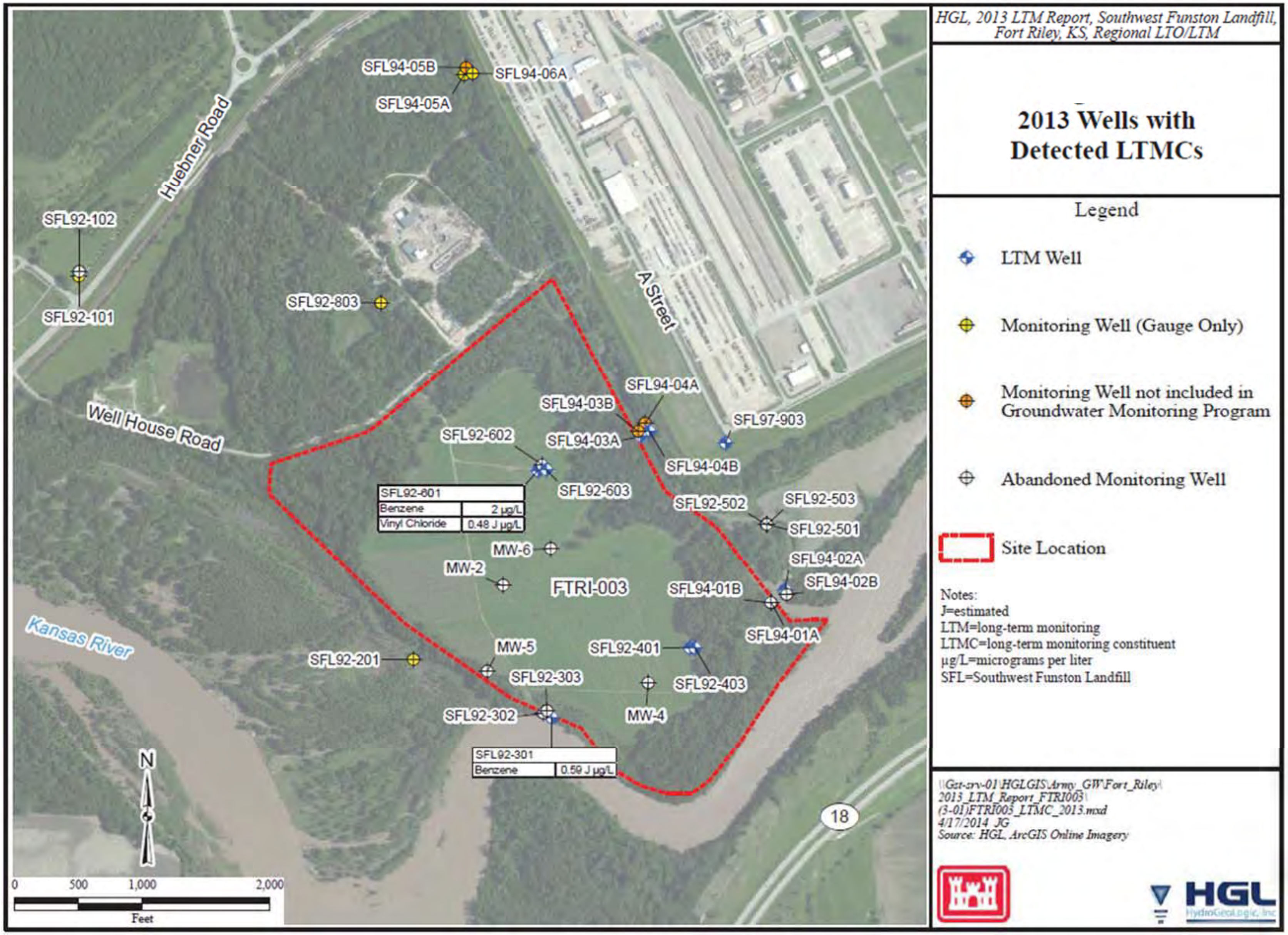

Figure 2-5. Detections of COCs in Groundwater, OU 001, 2013

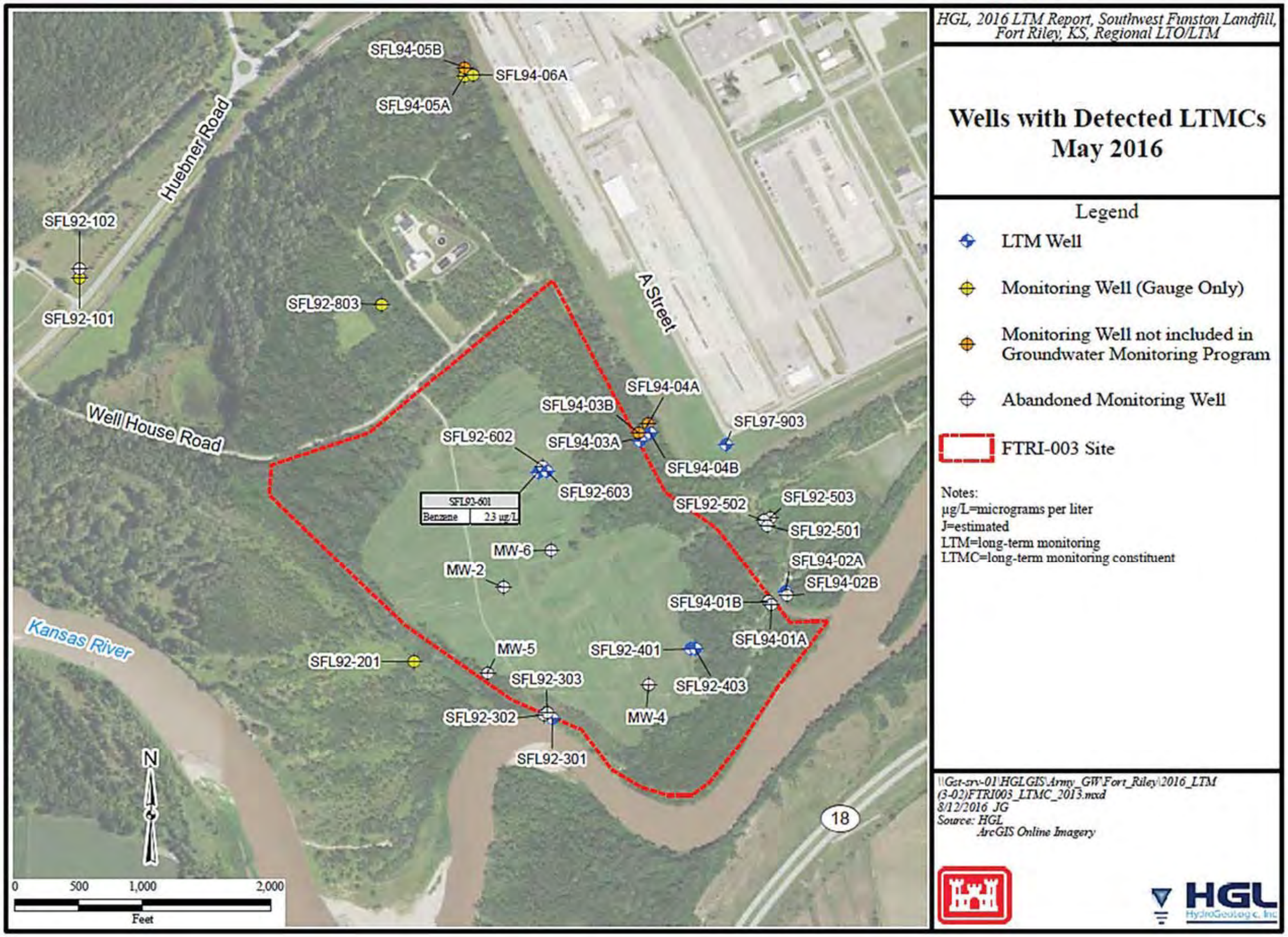

Figure 2-6. Detections of COCs in Groundwater, OU 001, 2016

OPERABLE UNIT 003
DRY CLEANING FACILITIES AREA

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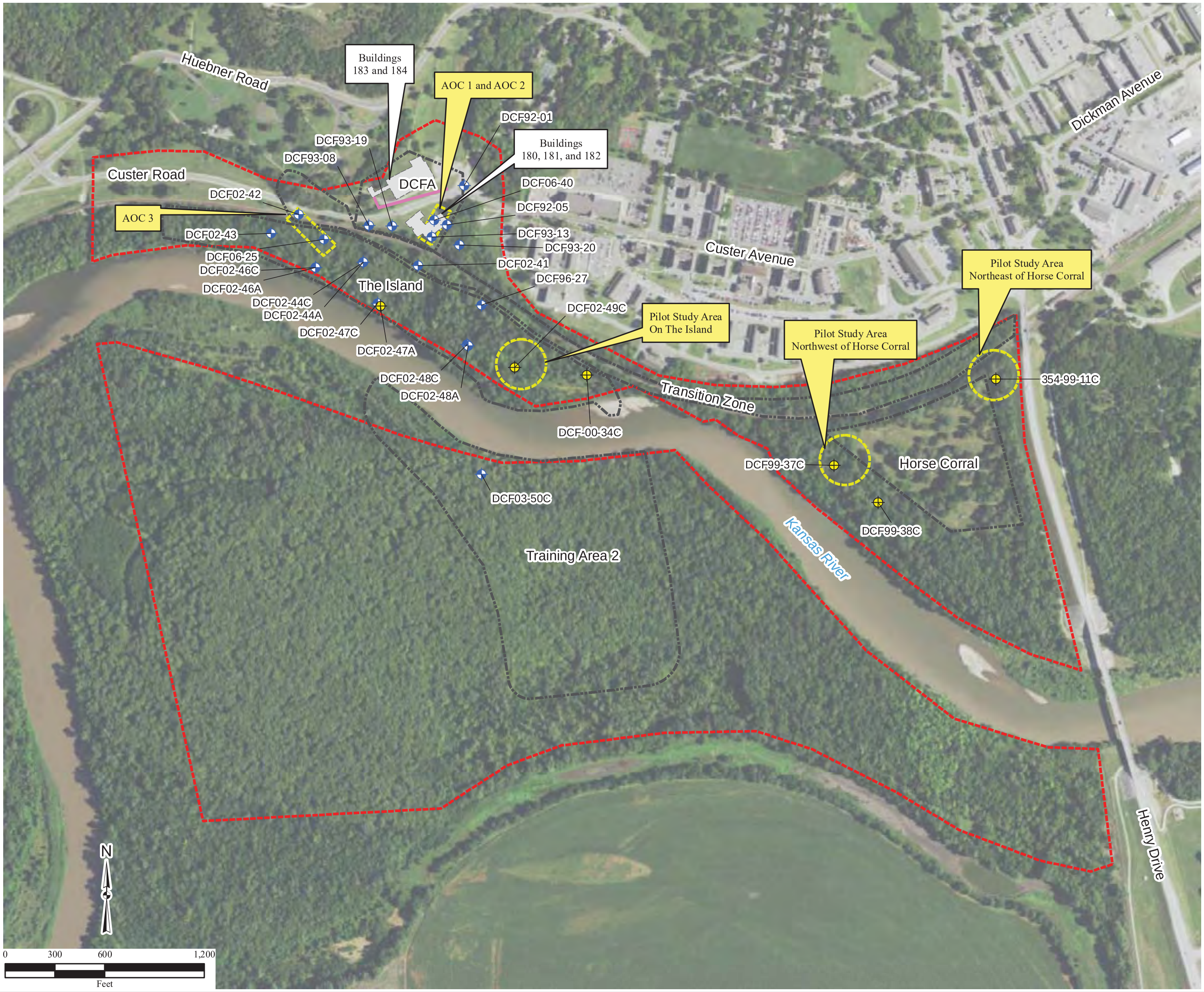

Site Features 2016

Legend

- ⊕ Monitoring Well (Gauged for Water Level Only)
- ⊕ LTM Monitoring Well
- ▭ FTRI-027 Investigation Area
- ▭ Pilot Study Area
- ■ Utility Corridor
- ▨ Former Structure
- ▭ FTRI-027 Site

Notes:
AOC=area of concern
DCFA=dry cleaning facilities area
LTM=long-term monitoring

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10/5/2016 JG
Source: HGL,
ArcGIS Online Imagery

Figure 3-1. Location and Site Features of OU003

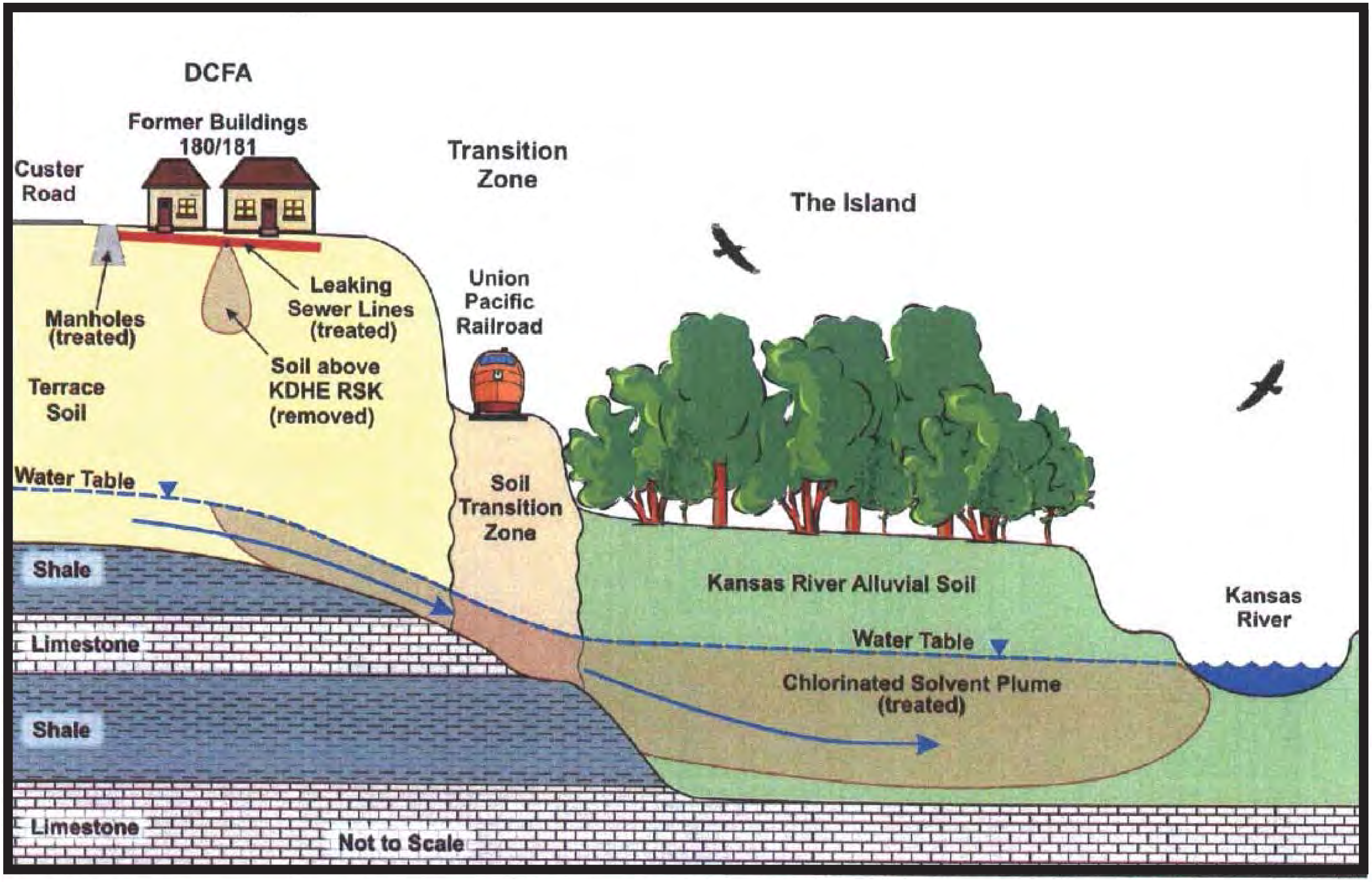
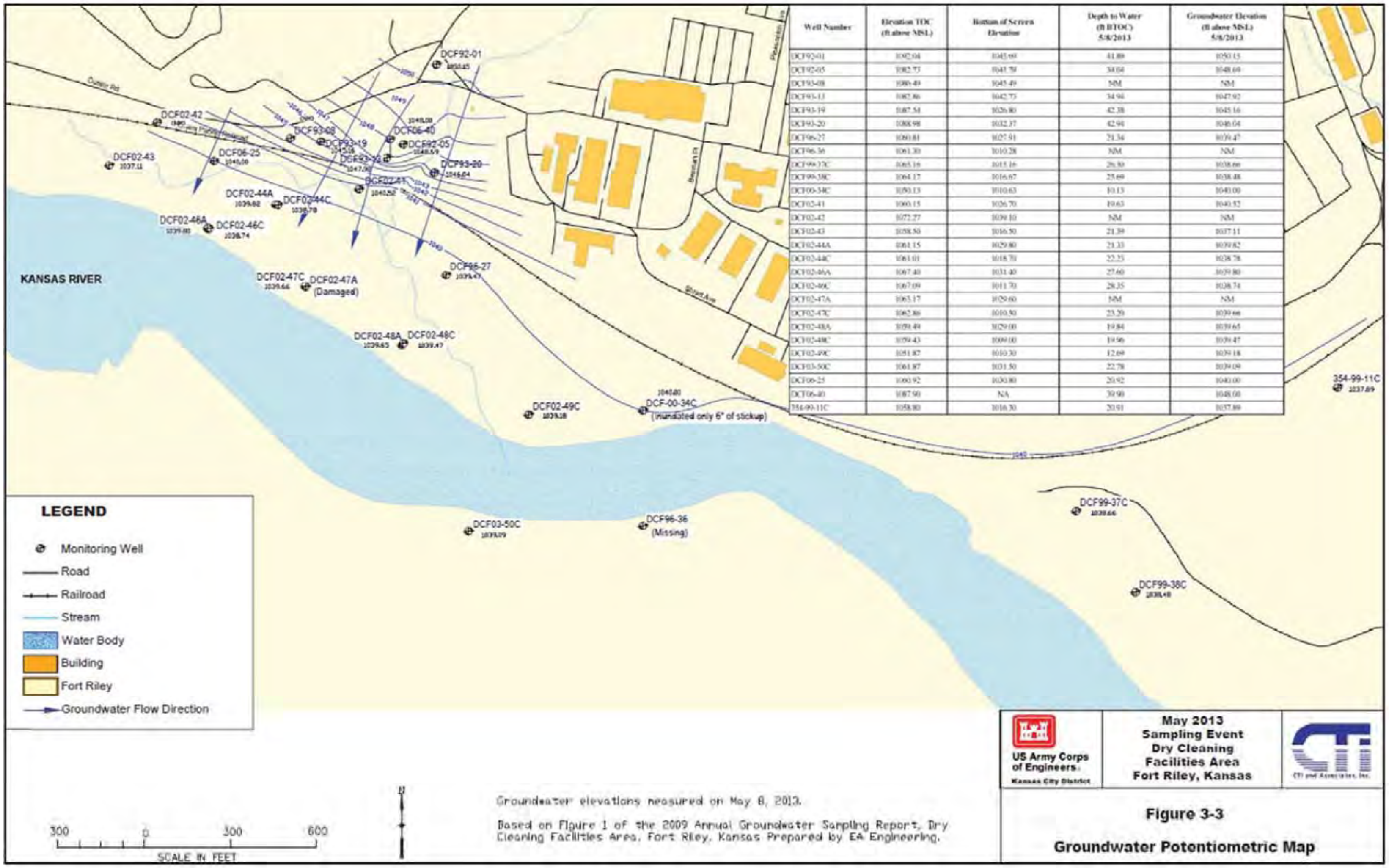


Figure 3-2. Schematic Representation of Conceptual Site Model for OU 003



Well Number	Elevation TOC (ft above MSL)	Bottom of Screen Elevation	Depth to Water (ft BTOC) 5/8/2013	Groundwater Elevation (ft above MSL) 5/8/2013
DCF92-01	1092.04	1043.69	41.89	1050.15
DCF92-05	1082.73	1041.79	34.04	1048.69
DCF93-08	1080.49	1045.49	NM	NM
DCF93-13	1082.86	1042.73	34.94	1047.92
DCF93-19	1087.54	1026.80	42.38	1045.16
DCF93-20	1088.98	1032.37	42.94	1046.04
DCF96-27	1060.81	1027.91	21.34	1039.47
DCF96-36	1061.30	1010.28	NM	NM
DCF99-37C	1065.16	1015.16	26.50	1038.66
DCF99-38C	1064.17	1016.67	25.69	1038.48
DCF00-34C	1050.13	1010.63	10.13	1040.00
DCF02-41	1060.15	1026.70	19.63	1040.52
DCF02-42	1072.27	1039.10	NM	NM
DCF02-43	1058.50	1016.50	21.39	1037.11
DCF02-44A	1061.15	1029.80	21.33	1039.82
DCF02-44C	1061.01	1018.70	22.23	1038.78
DCF02-46A	1067.40	1031.40	27.60	1039.80
DCF02-46C	1067.09	1011.70	28.35	1038.74
DCF02-47A	1063.17	1029.60	NM	NM
DCF02-47C	1062.86	1010.50	23.20	1039.66
DCF02-48A	1059.49	1029.00	19.84	1039.65
DCF02-48C	1059.43	1009.00	19.96	1039.47
DCF02-49C	1051.87	1010.30	12.69	1039.18
DCF03-50C	1061.87	1031.50	22.78	1039.09
DCF06-25	1060.92	1030.80	20.92	1040.00
DCF06-40	1087.90	NA	39.90	1048.00
354-99-11C	1058.80	1016.30	20.91	1037.89

Groundwater elevations measured on May 8, 2013.

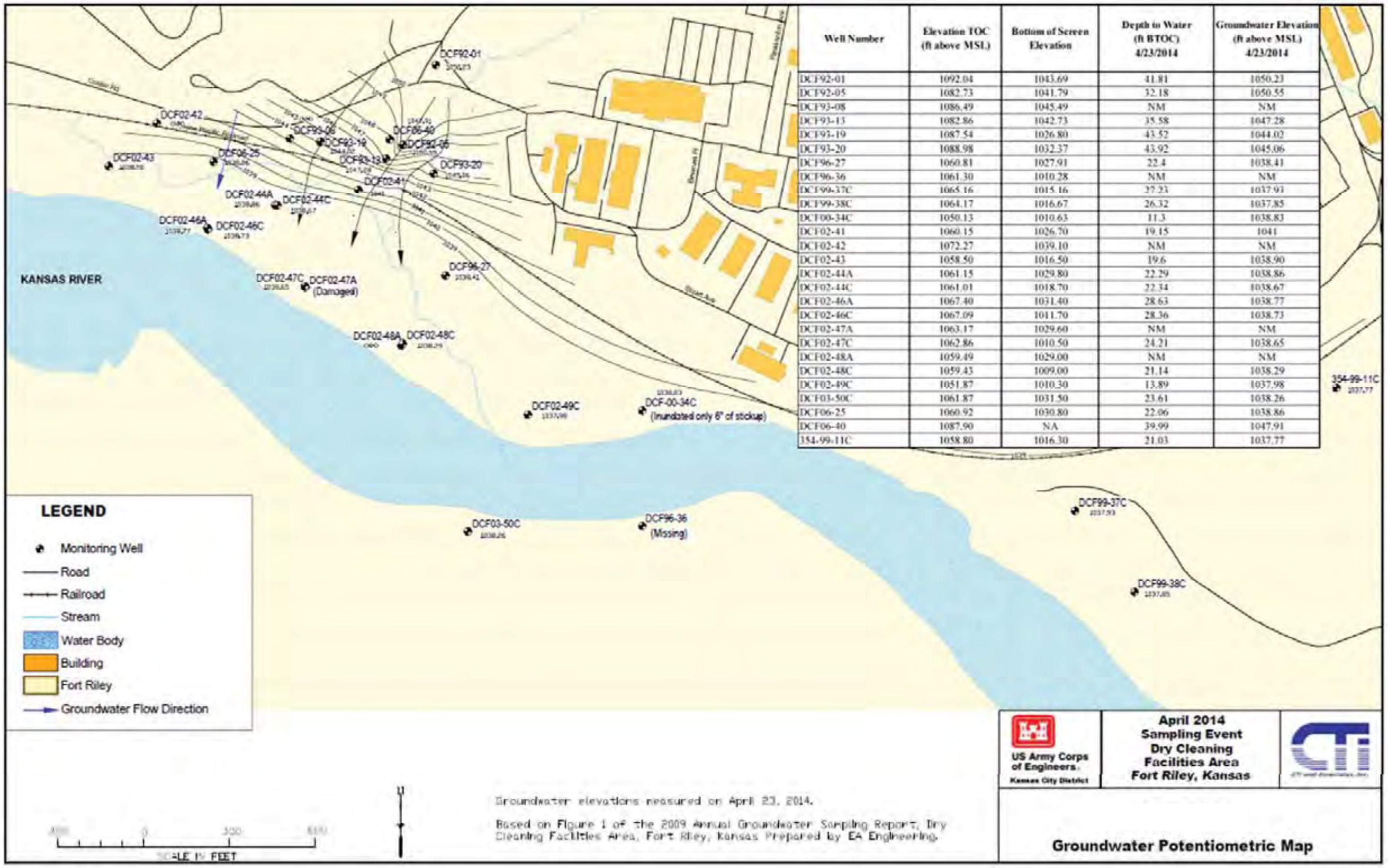
Based on Figure 1 of the 2009 Annual Groundwater Sampling Report, Dry Cleaning Facilities Area, Fort Riley, Kansas Prepared by EA Engineering.

May 2013
Sampling Event
Dry Cleaning
Facilities Area
Fort Riley, Kansas

Figure 3-3

Groundwater Potentiometric Map

Figure 3-3. Groundwater Potentiometric Map, OU 003, 2013



Well Number	Elevation TOC (ft above MSL)	Bottom of Screen Elevation	Depth to Water (ft BTOC) 4/23/2014	Groundwater Elevation (ft above MSL) 4/23/2014
DCF92-01	1092.04	1043.69	41.81	1050.23
DCF92-05	1082.73	1041.79	32.18	1050.55
DCF93-08	1086.49	1045.49	NM	NM
DCF93-13	1082.86	1042.73	35.58	1047.28
DCF93-19	1087.54	1026.80	43.52	1044.02
DCF93-20	1088.98	1032.37	43.92	1045.06
DCF96-27	1060.81	1027.91	22.4	1038.41
DCF96-36	1061.30	1010.28	NM	NM
DCF99-37C	1065.16	1015.16	27.23	1037.93
DCF99-38C	1064.17	1016.67	26.32	1037.85
DCF00-34C	1050.13	1010.63	11.3	1038.83
DCF02-41	1060.15	1026.70	19.15	1041
DCF02-42	1072.27	1039.10	NM	NM
DCF02-43	1058.50	1016.50	19.6	1038.90
DCF02-44A	1061.15	1029.80	22.29	1038.86
DCF02-44C	1061.01	1018.70	22.34	1038.67
DCF02-46A	1067.40	1031.40	28.63	1038.77
DCF02-46C	1067.09	1011.70	28.36	1038.73
DCF02-47A	1063.17	1029.60	NM	NM
DCF02-47C	1062.86	1010.50	24.21	1038.65
DCF02-48A	1059.49	1029.00	NM	NM
DCF02-48C	1059.43	1009.00	21.14	1038.29
DCF02-49C	1051.87	1010.30	13.89	1037.98
DCF03-50C	1061.87	1031.50	23.61	1038.26
DCF06-25	1060.92	1030.80	22.06	1038.86
DCF06-40	1087.90	NA	39.99	1047.91
354-99-11C	1058.80	1016.30	21.03	1037.77

Groundwater elevations measured on April 23, 2014.

Based on Figure 1 of the 2009 Annual Groundwater Sampling Report, Dry Cleaning Facilities Area, Fort Riley, Kansas Prepared by EA Engineering.

April 2014
Sampling Event
Dry Cleaning
Facilities Area
Fort Riley, Kansas

Groundwater Potentiometric Map

Figure 3-4. Groundwater Potentiometric Map, OU 003, 2014

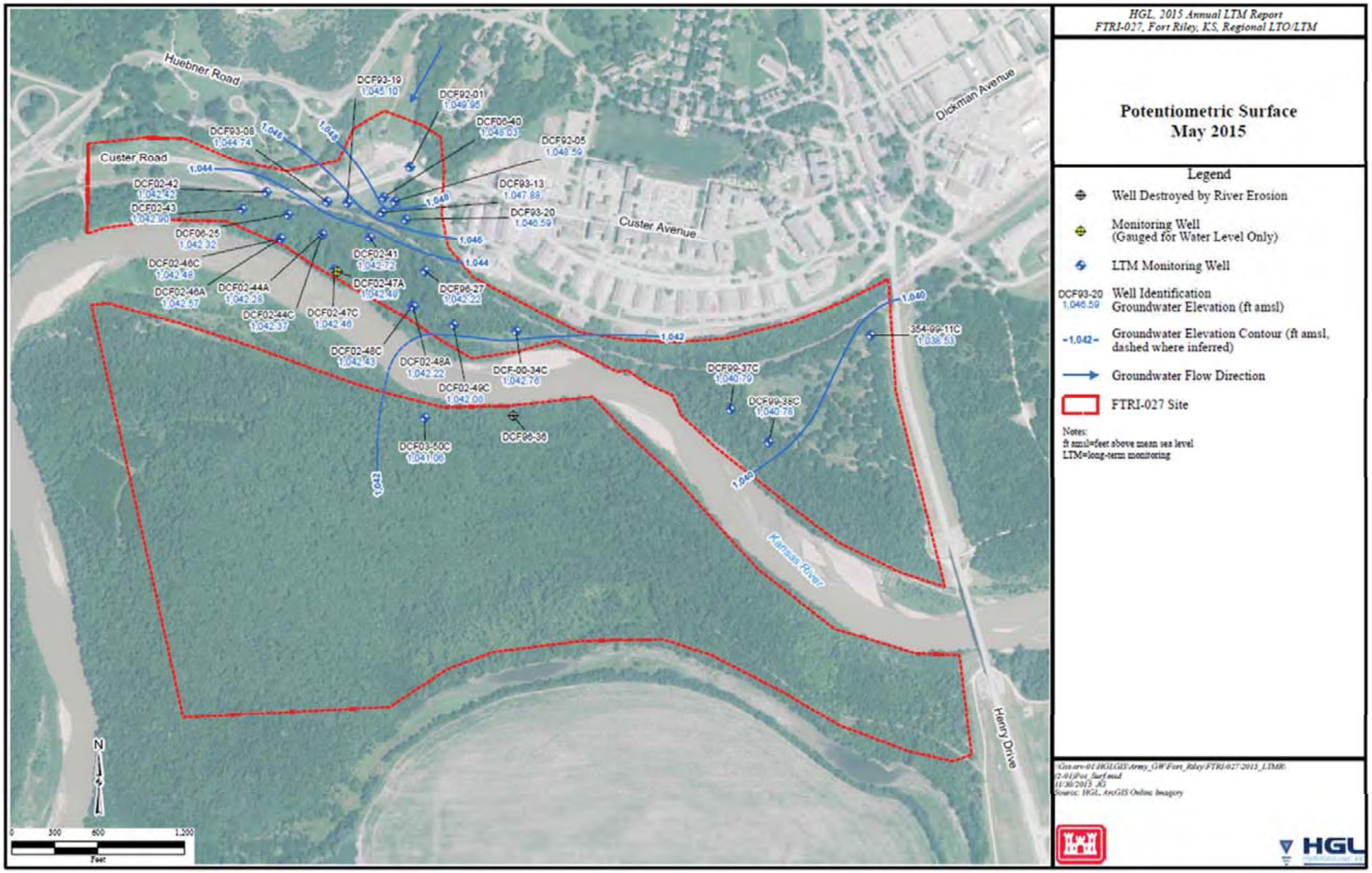
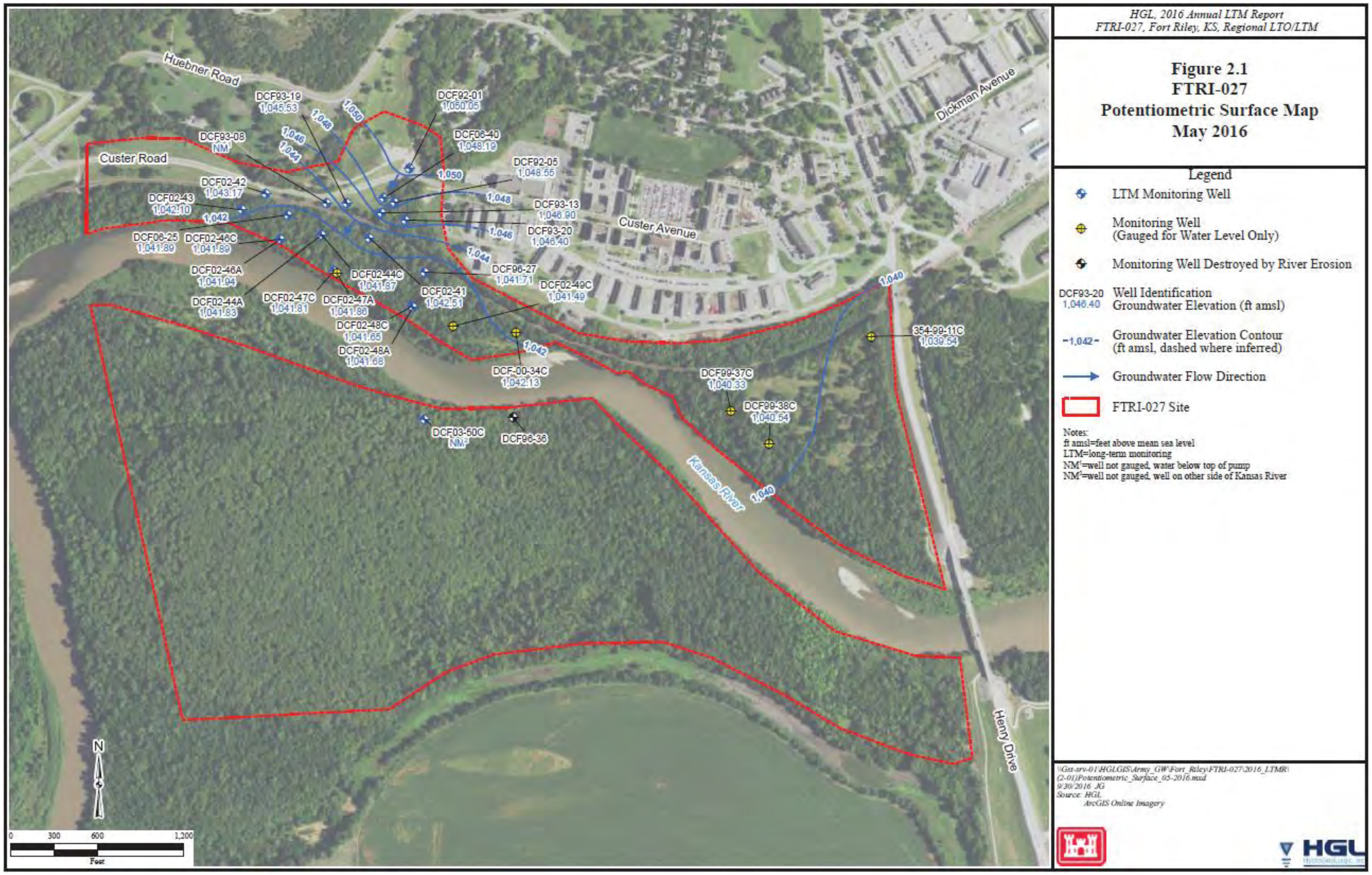


Figure 3-5. Groundwater Potentiometric Map, OU 003, 2015



HGL, 2016 Annual LTM Report
FTRI-027, Fort Riley, KS, Regional LTO/LTM

Figure 2.1
FTRI-027
Potentiometric Surface Map
May 2016

Notes:
ft amsl=feet above mean sea level
LTM=long-term monitoring
NM¹=well not gauged, water below top of pump
NM²=well not gauged, well on other side of Kansas River

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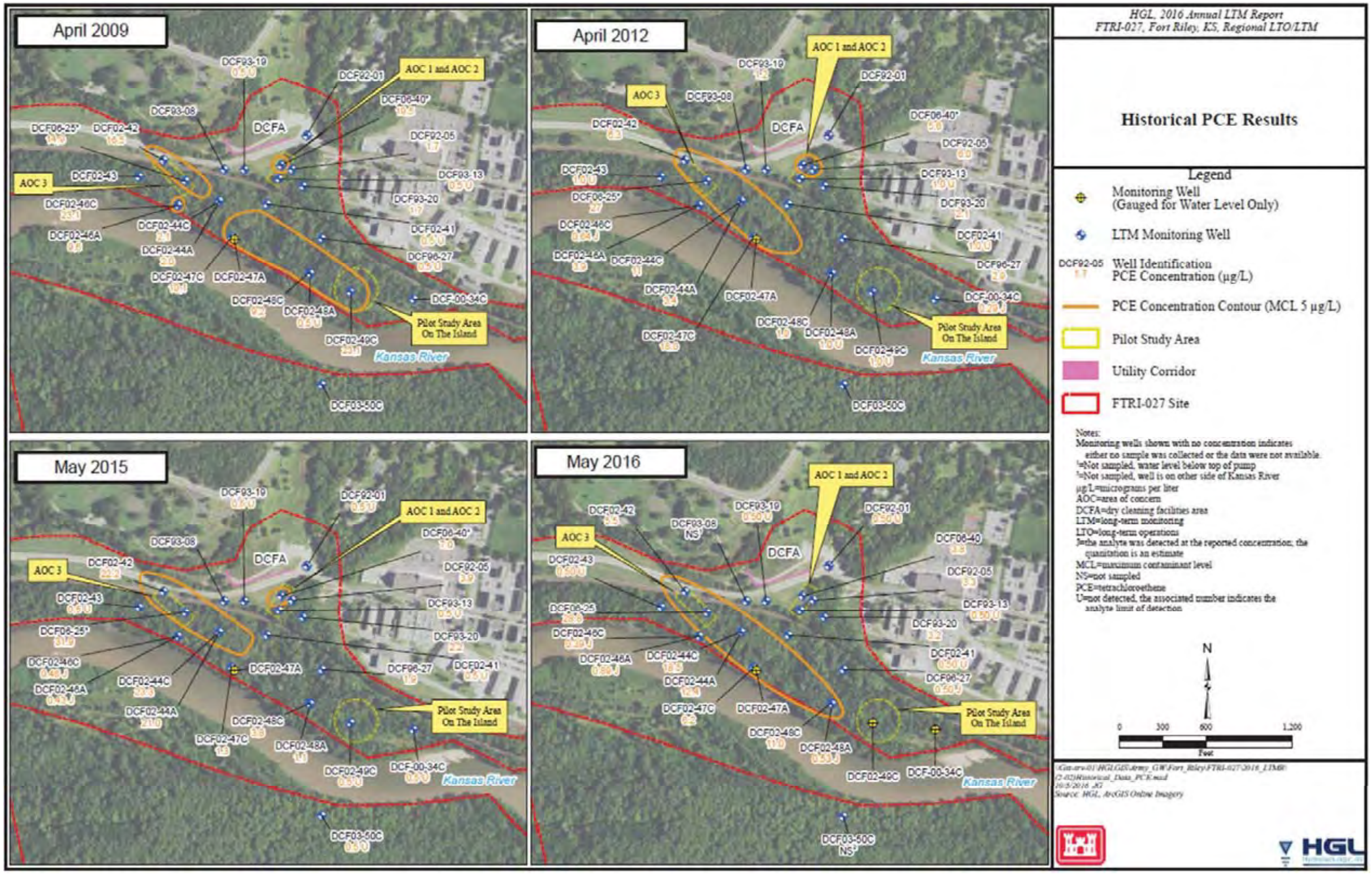
9/30/2016 JG
Source: HGL
ArcGIS Online Imagery

Figure 3-6. Groundwater Potentiometric Map, OU 003, 2016



Notes:
Monitoring wells shown with no concentration indicates either no sample was collected or the data were not available.
[1]=Not sampled, water level below top of pump
[2]=Not sampled, well is on other side of Kansas River
µg/L=micrograms per liter
AOC=area of concern
DCFA=dry cleaning facilities area
LTM=long-term monitoring
LTO=long-term operations
J=the analyte was detected at the reported concentration; the quantitation is an estimate
MCL=maximum contaminant level
NS=not sampled
PCE=tetrachloroethene
U=not detected, the associated number indicates the analyte limit of detection

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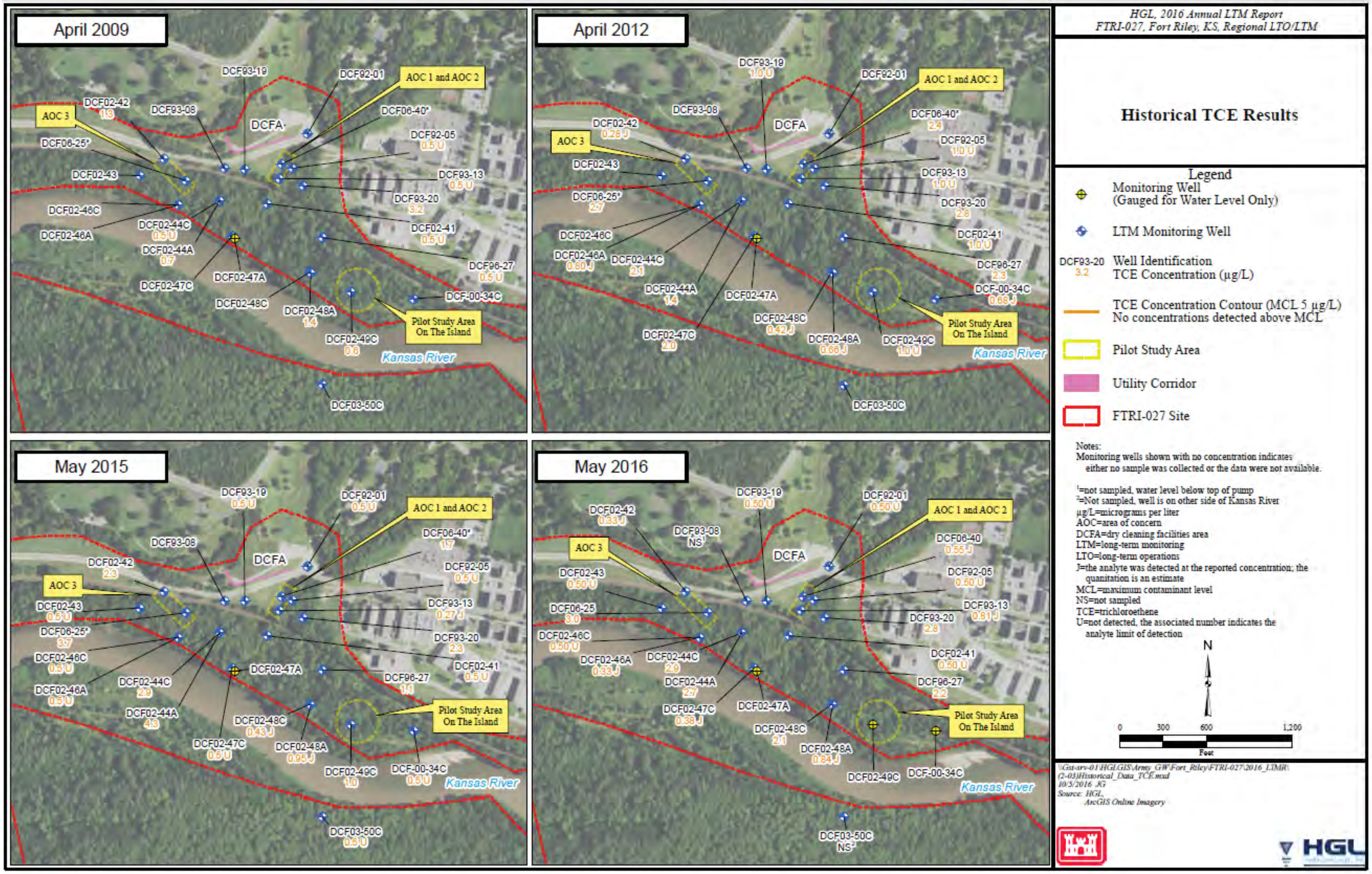
10/5/2016 JG
Source: HGL, ArcGIS Online Imagery

Figure 3-7. Location of Historical Concentrations of PCE, PCE



Notes:
Monitoring wells shown with no concentration indicates either no sample was collected or the data were not available.

[1]=not sampled, water level below top of pump
[2]=Not sampled, well is on other side of Kansas River
µg/L=micrograms per liter
AOC=area of concern
DCFA=dry cleaning facilities area
LTM=long-term monitoring
LTO=long-term operations
J=the analyte was detected at the reported concentration; the quanitation is an estimate
MCL=maximum contaminant level
NS=not sampled
TCE=trichloroethene
U=not detected, the associated number indicates the analyte limit of detection

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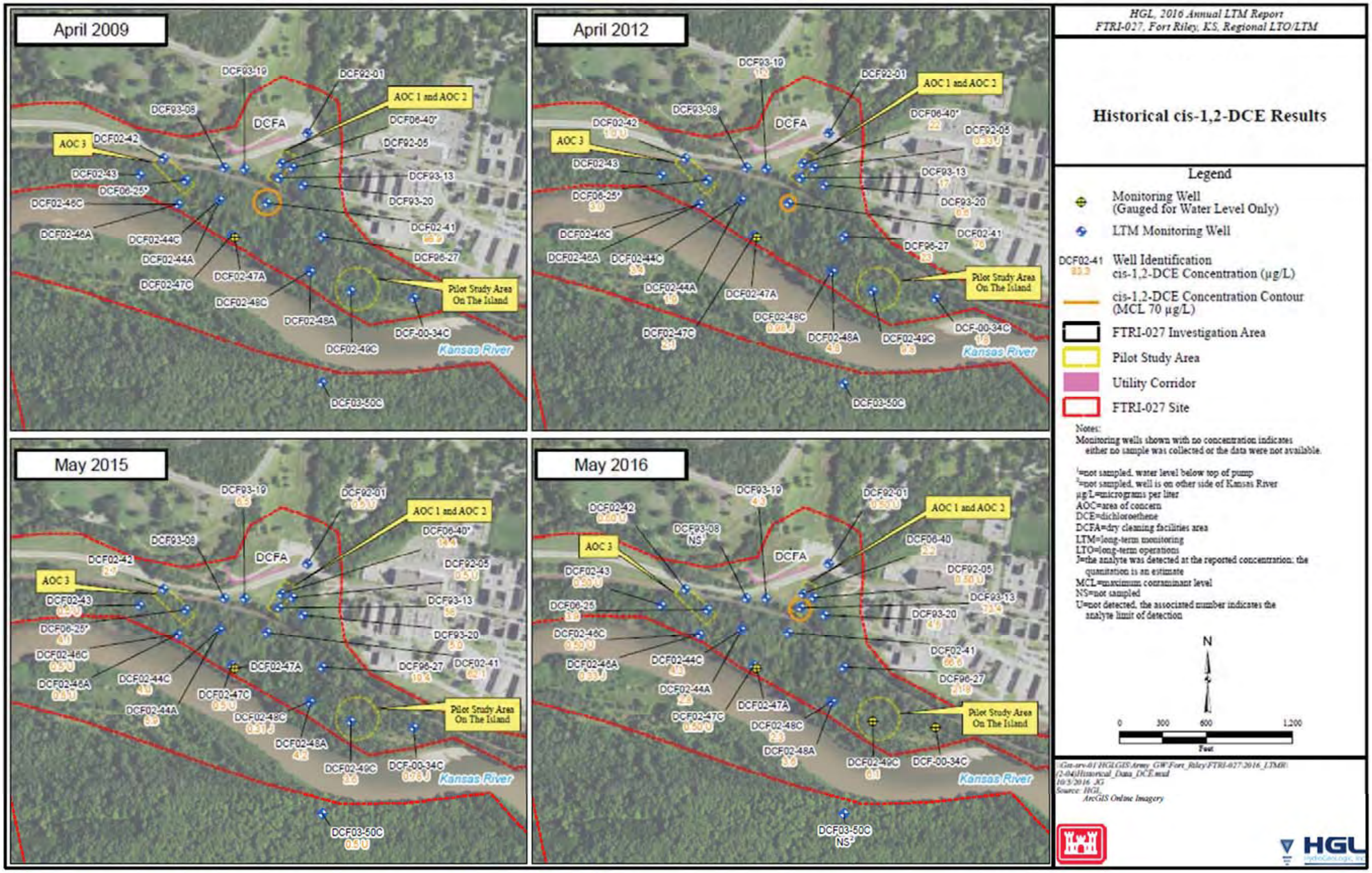
10/5/2016 JG
Source: HGL,
ArcGIS Online Imagery

Figure 3-8. Historical Concentrations of TCE



Notes:
Monitoring wells shown with no concentration indicates either no sample was collected or the data were not available.

[1]=not sampled, water level below top of pump
[2]=not sampled, well is on other side of Kansas River
µg/L=micrograms per liter
AOC=area of concern
DCE=dichloroethene
DCFA=dry cleaning facilities area
LTM=long-term monitoring
LTO=long-term operations
J=the analyte was detected at the reported concentration; the quantitation is an estimate
MCL=maximum contaminant level
NS=not sampled
U=not detected, the associated number indicates the analyte limit of detection

Figure 3-9. Historical Concentrations of cis-DCE, OU 003

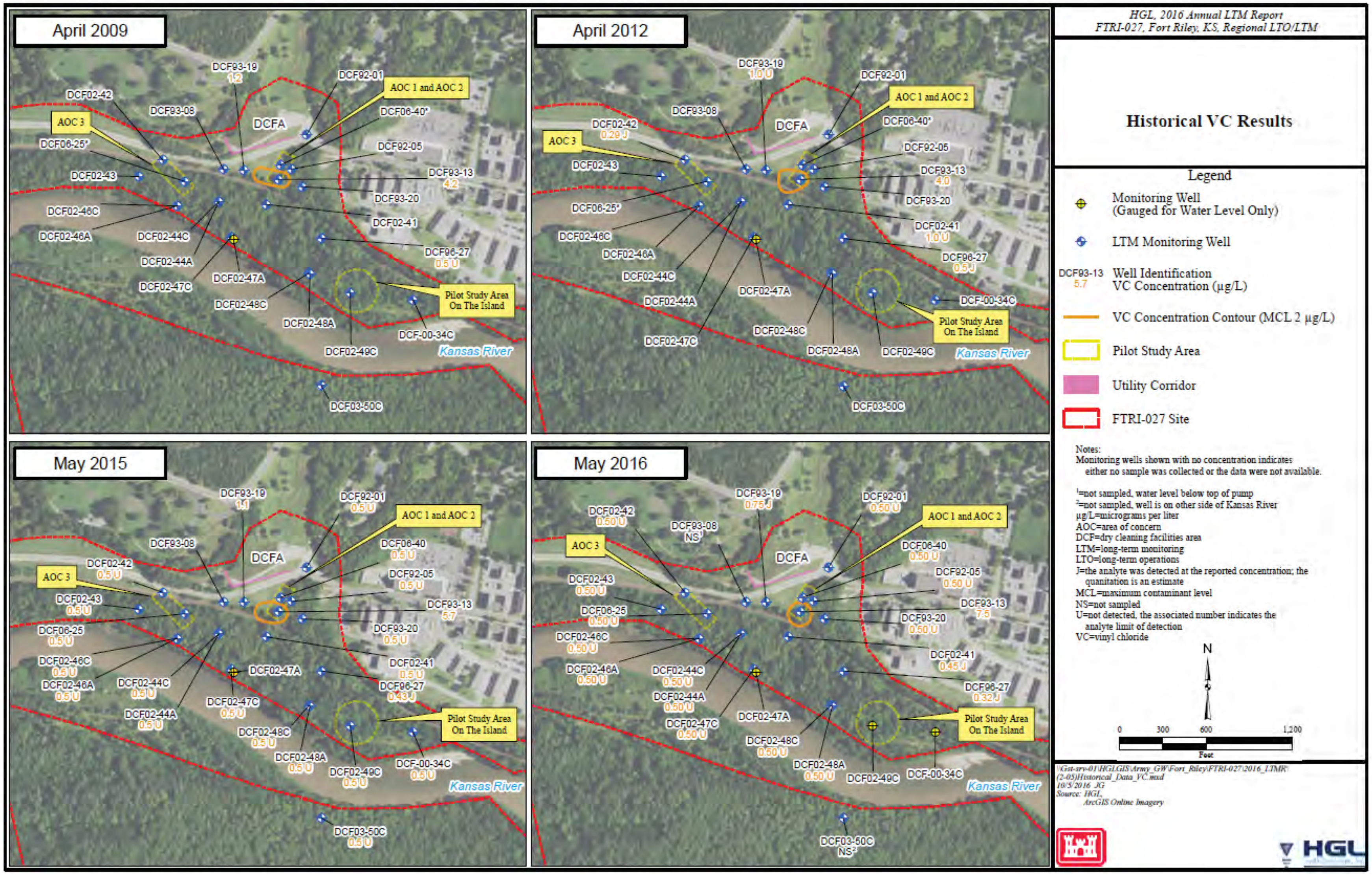


Figure 3-10. Historical Concentrations of VC, OU 003

OPERABLE UNIT 005
354 AREA SOLVENT DETECTIONS

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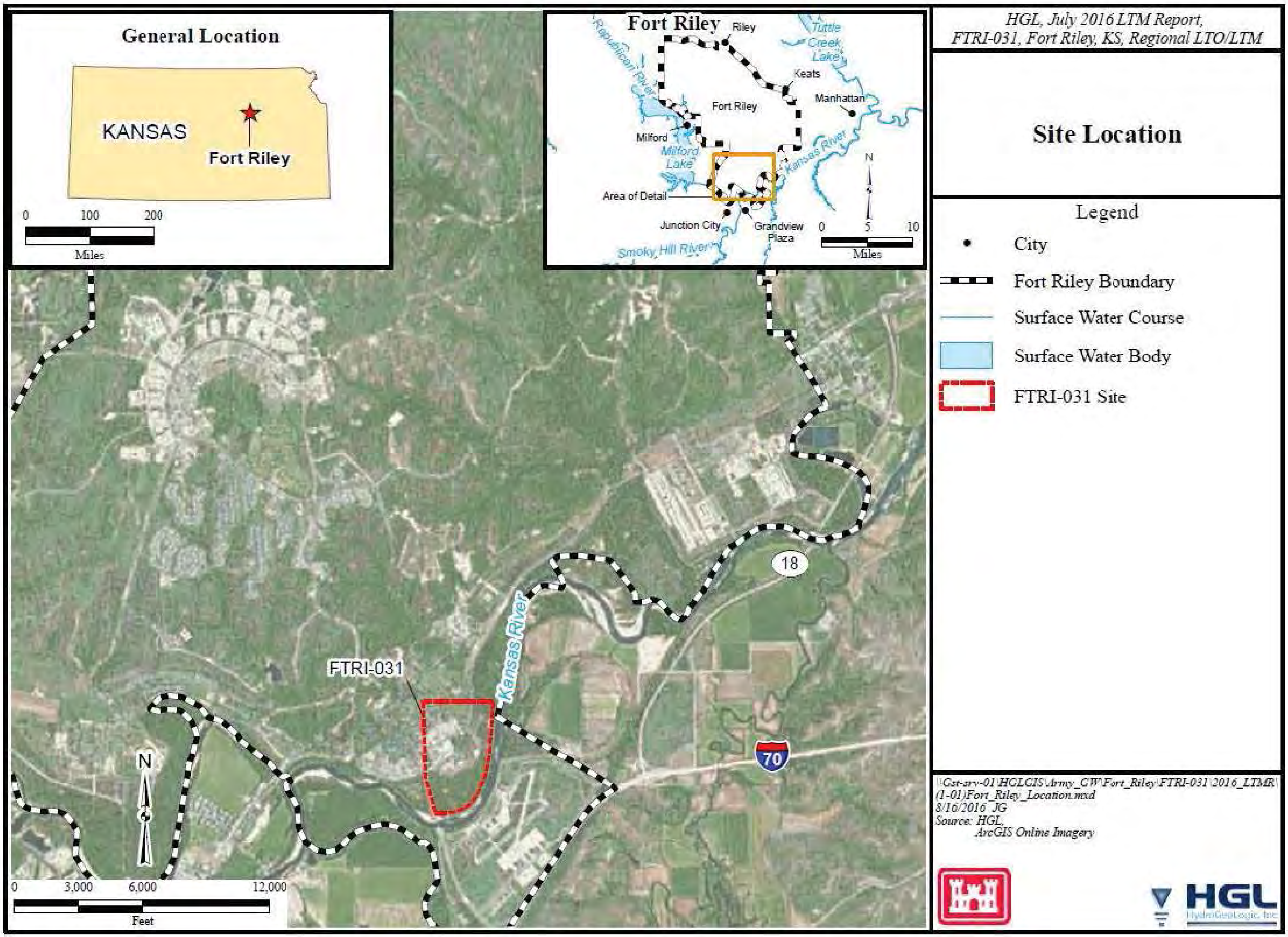


Figure 4-1. Location of OU 005

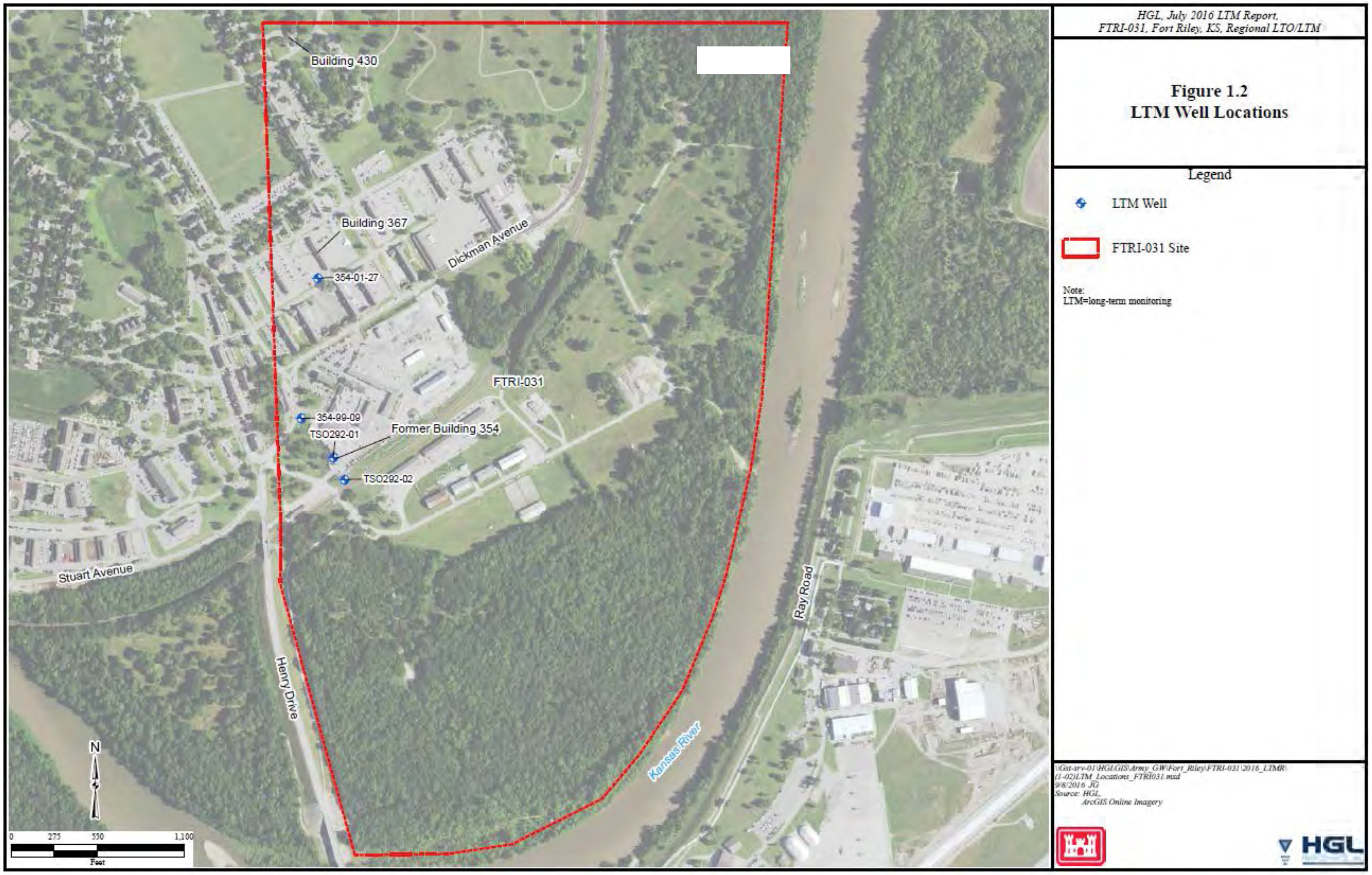
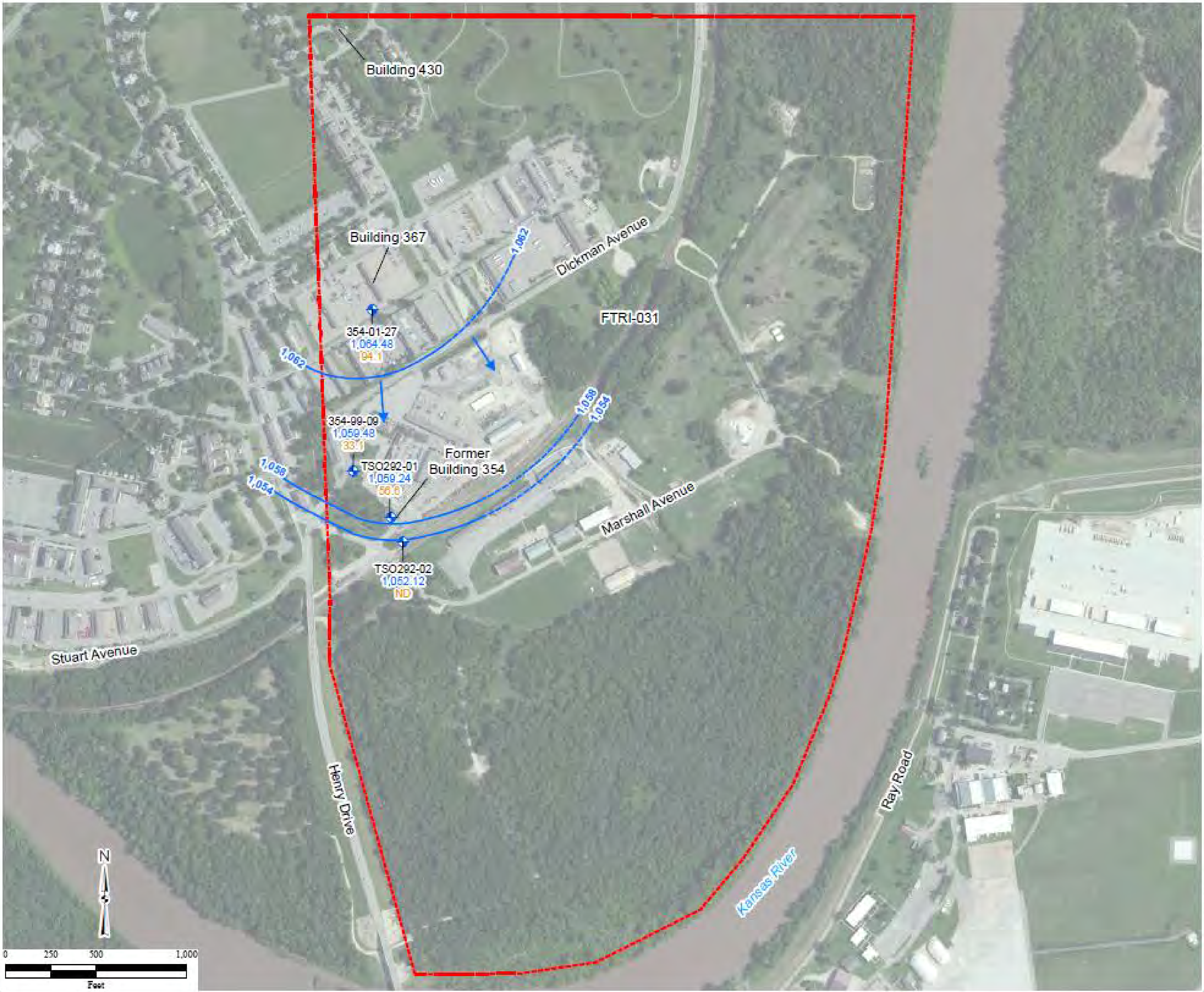


Figure 4-2. Site Layout of OU 005



HGL, 2014 Annual LTM Report,
FTRI-031, Fort Riley, KS, Regional LTO/LTM

Potentiometric Surface and
PCE Concentrations
FTRI-031, March 2014

Legend

- ⯐ LTM Well
- TSO292-01 — Monitoring Well Identification
- 1,059.24 — Groundwater Elevation (ft amsl)
- 56.6 — PCE Concentration (µg/L)
- -1,054- Groundwater Elevation Contour (ft amsl, dashed where inferred)
- → Direction of Inferred Groundwater Flow
- 🟥 Site Location

Notes:
ft amsl=feet above mean sea level
LTM=long term monitoring
µg/L=micrograms per liter
ND=nondetect
PCE=tetrachloroethene

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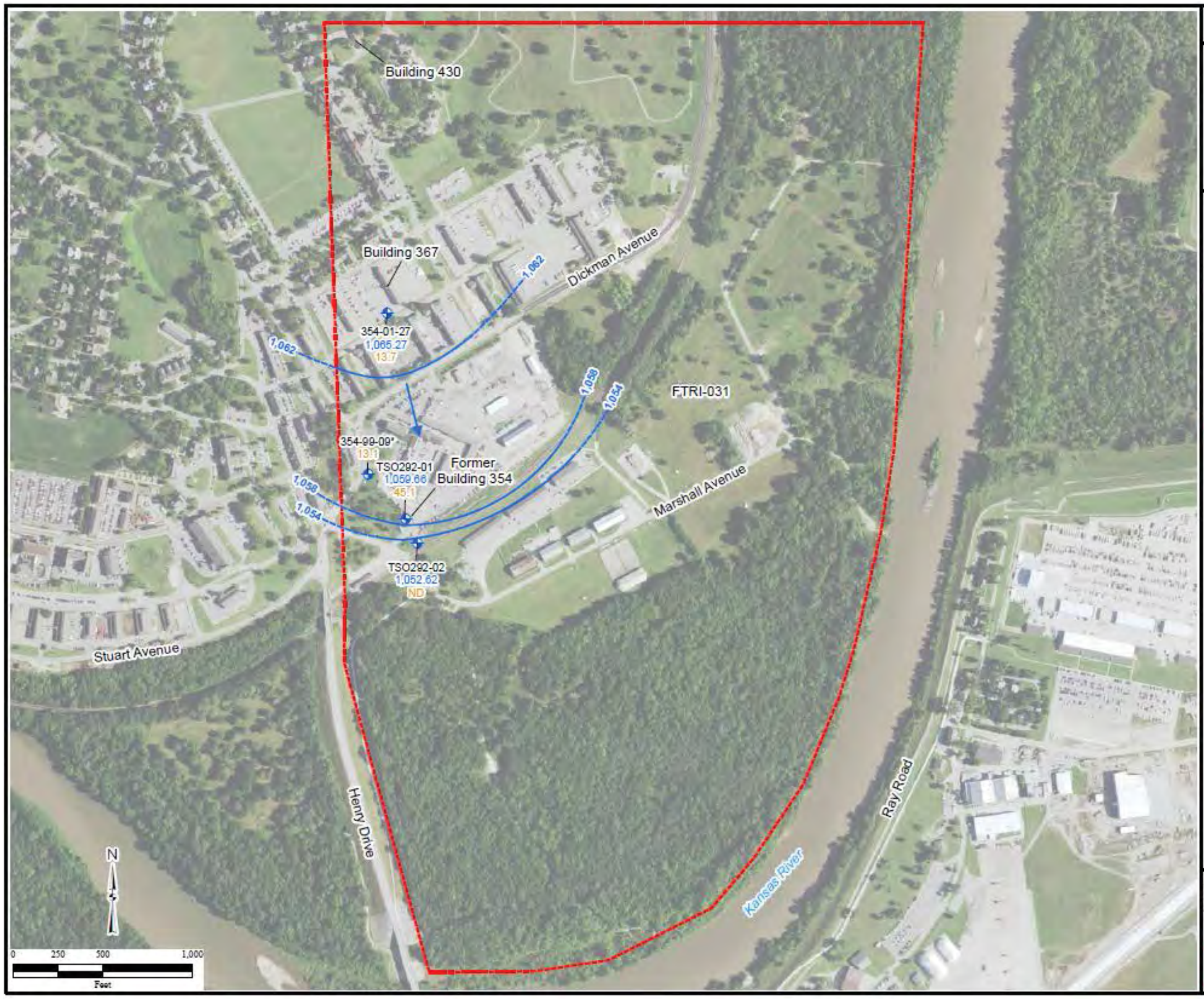
2/4/2015 JG
Source: HGL, ArcGIS Online Imagery

Figure 4-3. Groundwater Potentiometric Map, OU 005, March 2014



HGL, July 2016 LTM Report,
FTRI-031, Fort Riley, KS, Regional LTO/LTM

Potentiometric Surface and
PCE Concentrations
July 2016

Legend

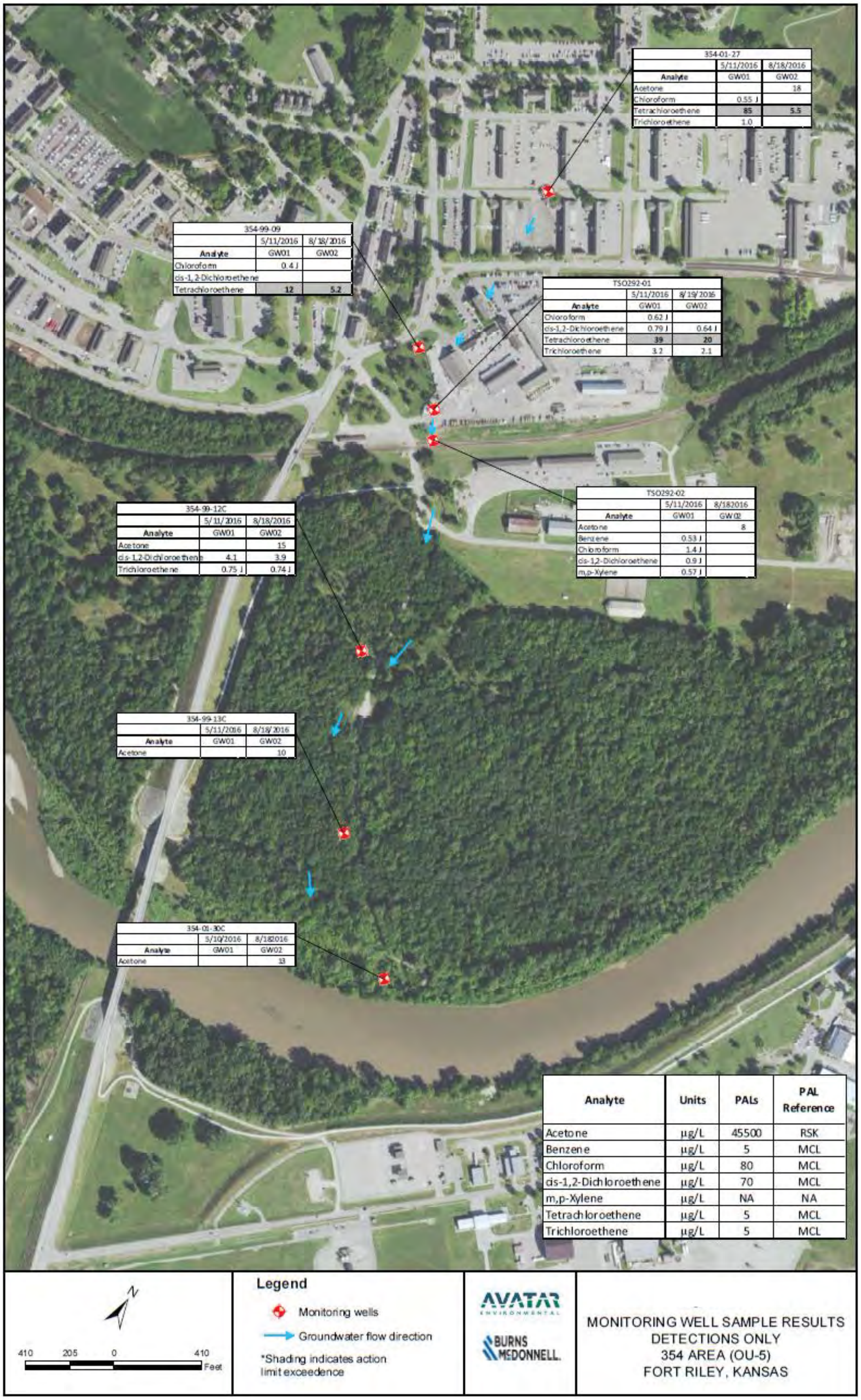
- LTM Well
- TSO292-01—Monitoring Well Identification
  1,059.66—Groundwater Elevation (ft amsl)
  45.1—PCE Concentration (µg/L)
- -1,054- Groundwater Elevation Contour (ft amsl, dashed where inferred)
- Direction of Inferred Groundwater Flow
- FTRI-031 Site

Notes:
*=water level below top of pump
µg/L=micrograms per liter
ft amsl=feet above mean sea level
LTM=long-term monitoring
ND=nondetect
PCE=tetrachloroethene

\\Gst-srv-01\HGLGIS\Army_GW\Fort_Riley\FTRI-031\2016_LTMR
(2-01)FTRI031_GW_Contours_07-2016.mxd
9/8/2016 JG
Source: HGL, ArcGIS Online Imagery

HGL

Figure 4-4. Groundwater Potentiometric Map, OU 005, July 2016



354-01-27		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		18
Chloroform	0.55 J	
Tetrachloroethene	85	5.5
Trichloroethene	1.0	

354-99-09		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Chloroform	0.4 J	
cis-1,2-Dichloroethene		
Tetrachloroethene	12	5.2

TSO292-01		
	5/11/2016	8/19/2016
Analyte	GW01	GW02
Chloroform	0.62 J	
cis-1,2-Dichloroethene	0.79 J	0.64 J
Tetrachloroethene	39	20
Trichloroethene	3.2	2.1

TSO292-02		
	5/11/2016	8/182016
Analyte	GW01	GW 02
Acetone		8
Benzene	0.53 J	
Chloroform	1.4 J	
cis-1,2-Dichloroethene	0.9 J	
m,p-Xylene	0.57 J	

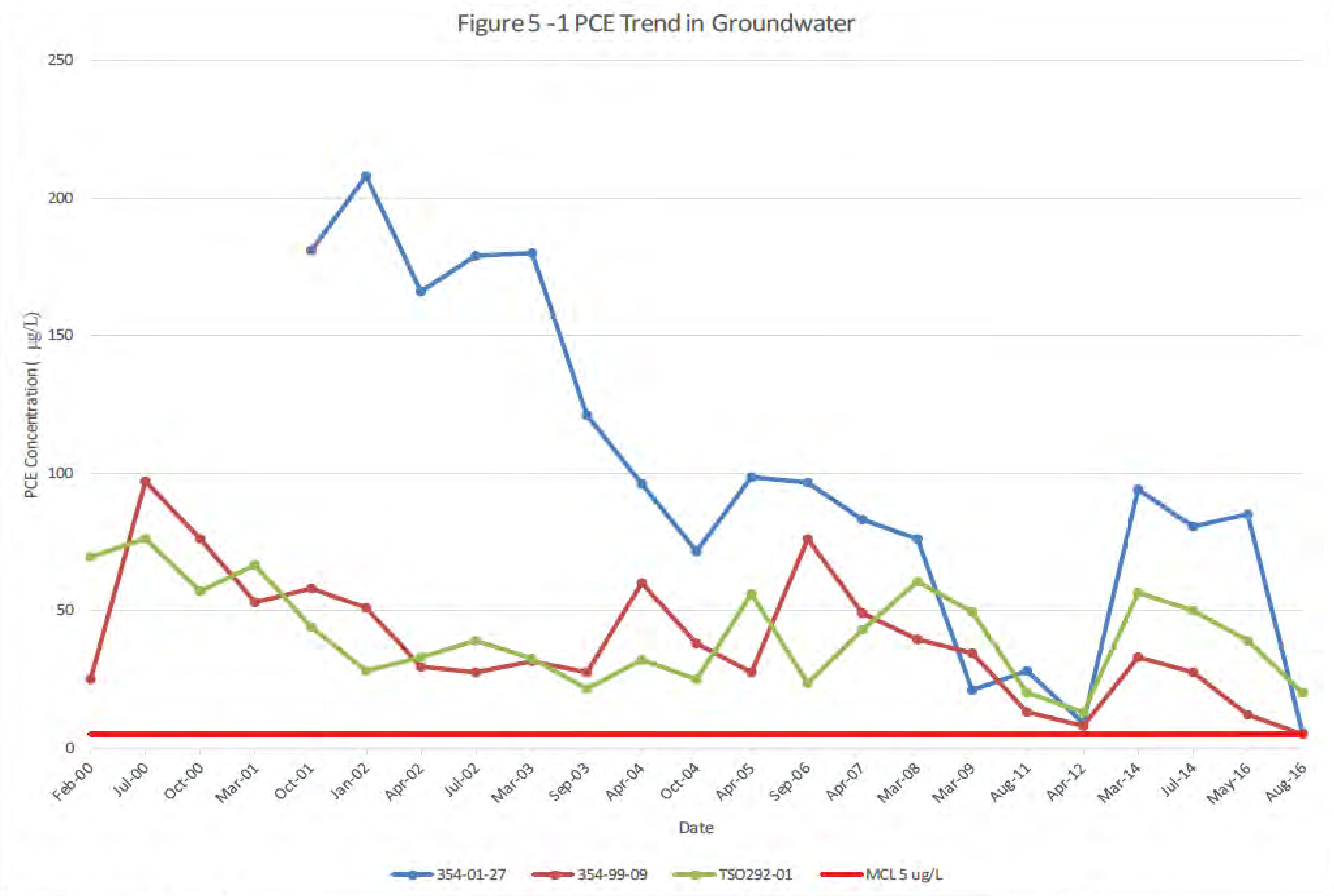
354-99-12C		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		15
cis-1,2-Dichloroethene	4.1	3.9
Trichloroethene	0.75 J	0.74 J

354-99-13C		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		10

354-01-30C		
	5/10/2016	8/182016
Analyte	GW01	GW02
Acetone		13

Analyte	Units	PALs	PAL Reference
Acetone	µg/L	45500	RSK
Benzene	µg/L	5	MCL
Chloroform	µg/L	80	MCL
cis-1,2-Dichloroethene	µg/L	70	MCL
m,p-Xylene	µg/L	NA	NA
Tetrachloroethene	µg/L	5	MCL
Trichloroethene	µg/L	5	MCL

Figure 4-5. PCE Concentrations at OU 005, May and August 2016



Note: Red line indicates the Federal Maximum Contaminant Level of 5 µg/l

Figure 5-1
PCE TREND IN GROUNDWATER
354 AREA (OU-5)
FORT RILEY, KANSAS

Figure 4-6. PCE Trend in Groundwater at OU 005, 2000-2016

APPENDIX A

RECORD OF DECISION SUMMARY TABLES

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APPENDIX A-1

OPERABLE UNIT 001
SOUTHWEST FUNSTON LANDFILL

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Decision Document Summary
Fort Riley, KS
South Funston Landfill
Operational Unit OU 001
IRP Site Number FTRI-003

Decision Document Title:	Record of Decision, Southwest Funston Landfill. Operational Unit 001, Fort Riley, Kansas, November 1995
Army Signature:	Col. Kent D. Thomas, April 1997
Regulator (support agency acceptance):	USEPA, KDHE
Public Involvement :	<u>Proposed Plan</u> Public Comment Period: 9 November to 9 December, 1994. No public comments submitted. Public Meeting: 15 October 1994. No comments made by the public during the meeting.
Regulatory Framework:	CERCLA NPL
Federal Facility Agreement:	KS6214020756; Federal Facility Agreement (FFA) Docket Number VII-90-0015, 28 June 1991
Land Use:	Current: Closed Landfill Future: Closed Landfill
Media of Concern:	Waste and Groundwater
Human Receptors of Concern and Exposure Pathways :	“The Baseline Risk Assessment evaluated the health effects which could potentially result from exposure by ingestion inhalation and dermal contact with constituents detected at the site. Risks were estimated for eighteen (18) current and/or future exposure scenarios They are Current: Occupational Services (exposures that may occur during work on utility lines associated adjacent to Threemile Creek or other on site activities) - Dermal contact with surface water, Dermal contact with sediments. Recreation Hunter Scenarios (exposures that may occur as a result of present-day hunters on the SFL) -Incidental ingestion of soil, Inhalation of fugitive dust, Dermal contact with soil Future: Occupational Scenarios (exposures that may be experienced by future maintenance/grounds keeping employees at the SFL) - Dermal contact with surface water, Dermal contact with sediments, Incidental ingestion of sediments, Incidental ingestion of soil, Inhalation of fugitive dust, Dermal contact with soil

	Recreational Hunter Scenarios (exposures that may occur as a result of future hunters at the SFL) -Incidental ingestion of soil, Inhalation of fugitive dust, Dermal contact with soil Future Hypothetical Land Uses Groundwater Scenarios (exposures that may occur from hypothetical future residents using groundwater from the water-bearing zone beneath the SFL) - Ingestion of drinking water, Inhalation of volatiles during bathing and household water use, Dermal contact while showering." [Page 2-10]
Ecological Receptors of Concern :	"Results of the ecological risk assessment indicate that risk to ecological receptors at the site is very slight. Negative impacts to flora and fauna by contaminants are not expected. Suitable habitat for several threatened or endangered species exists at the site. Though one species, the bald eagle, has been seen on occasion in areas bordering the site more suitable habitats and foraging areas exist in the general area. In addition signs of stress to the flora and fauna at the site were not observed. Therefore population-scale effects on ecological receptors at the site are not anticipated." [Page 2-17]
Chemicals of Concern:	**Groundwater:** antimony arsenic, benzene, beryllium, cis-1 3 dichloropropene, 1,2-dichloroethane 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and vinyl chloride [Page 2-8]
Conceptual Site Model	"The predominant contaminant migration pathway at the SFL is for contaminants to leach or migrate from the landfill contents to the groundwater. Contaminants can be mobilized from the landfill by percolating rainwater that might carry contamination down to the water table. Contaminants can also be mobilized when the water table rises into the landfill and saturates the waste. The water table is influenced in part by the stage of the Kansas River. Groundwater from beneath the landfill is interpreted to primarily discharge to Threemile Creek (directly east of the SFL) and the Kansas River Once in the groundwater the contaminants may be transported toward the Kansas River and Threemile Creek. The potential exists for the contaminants in the groundwater to migrate to the river or the creek as the groundwater discharges into these surface water features. The Kansas River and Threemile Creek do not appear to be impacted by the landfill based on the absence of site related constituents above background concentrations. Because the groundwater flow conditions vary it is possible for contaminated groundwater to pass under Threemile Creek and then flow to the Kansas River. VOCs are the predominant groundwater contaminants most likely to migrate in this manner at the site. The VOCs would likely evaporate once they are transported into the surface water." [Page 2-7 and 2-8]

Basis for Action	"Therefore, even though contaminant concentrations are decreasing due to natural attenuation and engineered remedial efforts, and despite the absence of human health or ecological risks before implementation of the engineered portions of the alternative selected for each AOC in the FSA, the current exceedances of MCLs in groundwater at AOC 3 provides the basis for action at the DCF Study Area." [Page 2-16]
Remedial Action Objectives:	"The remedial action objectives established for the SFL are as follows: • Minimize human and ecological direct contact with landfill contents • Reduce the potential for leachate generation by reducing storm water ponding and infiltration as practical • Stabilize the Kansas River bank slope adjacent to the SFL to prevent movement of the channel into the landfill and to prevent exposure and erosion of the landfill contents • Prevent ingestion inhalation and dermal contact with groundwater having organic contaminant concentrations exceeding the remediation goals (The remediation goals are listed in Table 2 3 which follows)" [Page 2-6]
Applicable or Relevant and Appropriate Requirements:	"Principal ARARs which are relevant and appropriate for the site are MCLs and RCRA Subtitle D Criteria for Municipal Solid Waste Landfills (40 CFR 258 60 and 258 61). Maximum Contaminant Levels (MCLs) commonly referred to as Drinking Water Standards are applicable to public water systems. While future use of site groundwater is unlikely there is a limited potential future threat to nearby downgradient groundwater users MCLs are therefore considered relevant and appropriate RCRA Subtitle D discusses criteria for cover construction and monitoring for solid waste landfills and is an ARAR which is relevant and appropriate to cover alternatives "principal ARARs which are relevant and appropriate for the site are MCLs and RCRA Subtitle D." [Page 2-18]
Remedy Chosen	"The remedy selected on the basis of conformity with the nine EPA criteria as discussed in the previous section is Alternative 3. This alternative includes institutional controls long-term groundwater monitoring Kansas River bank stabilization (installed in spring 1994 as part of the Removal Action) repairs (performed in 1995 as part of the Removal Action) and improvements to the existing soil cover (a 1996 project as an additional phase of the Removal Action) and a contingency for future remediation of groundwater." [Page 2-28]

Clean-Up Goals:

Table 2-3: COCs at OU001 - Southwest Funston Landfill

Constituents of Concern	Clean-Up Goals	Units	Notes
Benzene	5	ug/L	USEPA Drinking Water Standard
1,2 – Dicholoroethane	5	ug/L	USEPA Drinking Water Standard
cis-1,3 – Dichloropropene	0.28/2.8/28	ug/L	Remediation goal based on cancer risk NCP range
1,1,2,2 – Tetrachloroethane	0.042/0.42/4.2	ug/L	Remediation goal based on cancer risk NCP range
1,1,2 – Tetrachloroethane	3	ug/L	Remediation goas based on MCLG
Vinyl Chloride	2	ug/L	USEPA Drinking Water Standard

[Page 2-15]

Components of the Remedy:

"The remedy selected on the basis of conformity with the nine EPA criteria as discussed in the previous section is Alternative 3. This alternative includes institutional controls, long-term groundwater monitoring, Kansas River bank stabilization (installed in spring 1994 as part of the Removal Action), repairs (performed in 1995 as part of the Removal Action) and improvements to the existing soil cover (a 1996 project as an additional phase of the Removal Action) and a contingency for future remediation of groundwater."

"The institutional controls included in this alternative are groundwater monitoring land use controls and access controls The long-term groundwater monitoring program will focus on the perimeter of the landfill and will include groundwater sampling and analysis for VOCs antimony and lead. The groundwater monitoring program may utilize existing monitoring wells installed for the RI/FS and/or additional wells installed specifically for the long term monitoring program The objective of the monitoring program would be to monitor for increases in contaminant concentrations in the vicinity of the SFL which might warrant additional actions at the SFL and to determine if constituents from the SFL are migrating under Threemile Creek."

[Page 2-28]

**ESD Details:
(If Applicable)**

Not Applicable

APPENDIX A-2

OPERABLE UNIT 003
DRY CLEANING FACILITIES AREA

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Decision Document Summary
Fort Riley, KS
Dry Cleaning Facilities Area
Operational Unit OU 003
IRP Site Number FTRI-027

Decision Document Title:	Record of Decision, Dry Cleaning Facilities Study Area (Operable Unit 003), at Main Post, Fort Riley, Kansas, January 16, 2008
Army Signature:	Richard G. Pisbal, COL, Armor, Garrison Commander
Regulator (support agency acceptance):	USEPA, KDHE
Public Involvement :	Proposed Plan Public Comment Period, no public comments submitted 13 October 2007 (in conjunction with the Restoration Advisory Board [RAB] meeting) - No comments made by the public during the meeting.
Regulatory Framework:	CERCLA NPL
Federal Facility Agreement:	KS6214020756; Federal Facility Agreement (FFA) Docket Number VTJ-90-F-0015
Land Use	**Current** Buildings 180/181 and 182, and 183 and 184 and the surrounding parking lots and sidewalks were demolished in summer 2000 and 2002. After demolition, the site was graded and is now an open grassed field. (2-17) The Fort Riley Master Plan currently designates these areas, as well as the Transition Zone, the Island, Horse Corral, and TA2, as Open Areas, in which future development for residential or commercial industrial use would not be allowed (Parsons/Harland, Bartholomew, and Associates, 2000). Open areas have building restrictions and are used only for safety areas, utility clearances and easements, conservation areas, and buffer zones. Additionally, a portion of the DCF Study Area lies within the active flood plain of the Kansas River where land uses must be in compliance with Executive Order 11988 - Floodplain Management. This order restricts and places requirements on actions that occur within a floodplain. (2-15) **Future:** It is anticipated that land use activities within the DCF Study Area will remain unchanged into the foreseeable future based on these building restrictions. (2-15)

Conceptual Site Model	
Media of Concern	Groundwater “It is important to note that soil sources were removed during the pilot study conducted in the fall 2005 and spring 2006 and that soil is no longer a medium of concern.” [Page 2-17)
Chemicals of Concern	**Groundwater:** PCE, TCE, DCE, and VC (PCE is the primary contaminant)
Remedy Chosen:	“The selected remedy for the DCF Study Area at Fort Riley is Monitored Natural Attenuation (MNA) with Institutional Controls (ICs). [Page 1-2] “With this alternative, progress at the DCF Study Area will be monitored through groundwater sampling, and ICs will be implemented to restrict groundwater usage until remediation is complete. The primary IC implemented will be restricting the installation and use of groundwater supply wells at and downgradient of the DCF Study Area through the RPMP.” [Page 1-3]

Land Use:	**Current** Buildings 180/181 and 182, and 183 and 184 and the surrounding parking lots and sidewalks were demolished in summer 2000 and 2002. After demolition, the site was graded and is now an open grassed field. (2-17) The Fort Riley Master Plan currently designates these areas, as well as the Transition Zone, the Island, Horse Corral, and TA2, as Open Areas, in which future development for residential or commercial industrial use would not be allowed (Parsons/Harland, Bartholomew, and Associates, 2000). Open areas have building restrictions and are used only for safety areas, utility clearances and easements, conservation areas, and buffer zones. Additionally, a portion of the DCF Study Area lies within the active flood plain of the Kansas River where land uses must be in compliance with Executive Order 11988 - Floodplain Management. This order restricts and places requirements on actions that occur within a floodplain. (2-15) **Future:** It is anticipated that land use activities within the DCF Study Area will remain unchanged into the foreseeable future based on these building restrictions. (2-15)
Human Receptors of Concern :	Current groundskeeper Future Utility Workers Current Youth Trespassers

Exposure Pathway of Concern:	• Current Groundskeeper - Since grounds keeping activities typically involve mowing, direct contact with surface soil is likely to occur. Direct contact with surface soil could lead to incidental ingestion of and chemical absorption through dermal contact with surface soil. • Future Utility Workers - Since utility activities typically involve excavation of soil, utility workers could directly contact contaminated surface and shallow subsurface soils. Direct contact with surface and subsurface soil could lead to incidental ingestion of soil and chemical absorption through dermal contact with soil. Chemical vapors from VOCs detected in surface and subsurface soil are likely to be present in the breathing zone of a utility worker. Since VOCs were detected in the groundwater, inhalation of vapor phase chemicals is considered a potentially completed pathway. • Current Youth trespassers - Could directly contact contaminated surface soils. Direct contact with surface soil could lead to incidental ingestion and chemical absorption through dermal contact. Chemical vapors from VOCs present in surface and subsurface soil could migrate through soils and be present in the breathing zone of a youth trespasser. Chemical vapors from VOCs detected in surface and subsurface soil are likely to be present in the breathing zone of a utility worker. Since VOCs were detected in the groundwater, inhalation of vapor phase chemicals is considered a potentially completed pathway. Exposure to sediment was evaluated and the calculated risk levels were below the USEPA acceptable levels. [Pages 2-18, 2-19]
Ecological Receptors of Concern :	“Based on the available habitat at the DCF Study Area, wildlife receptors potentially present were identified and compared to a list of species for which benchmarks have been established (see Table 2-13 and 2-14). Terrestrial receptors selected as representative species included the little brown bat, short-tailed shrew, white-footed mouse, meadow vole (close relative and surrogate for the prairie vole), mink, eastern cottontail rabbit, red fox, and white-tailed deer.” [Page 2-23]
Remedial Action Objectives:	• Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration in groundwater of COPCs that exceed cleanup goals. • Achieve cleanup goals of MCLs for COPCs in groundwater in the Kansas River alluvium through the use of natural and/or active remedial processes. [Page 2-27]

Clean-Up Goals:	The remediation goal is to restore the groundwater to its beneficial use, which may include drinking water or non-domestic uses such as agricultural (livestock or irrigation). Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. (1-4) The clean-up levels for the DCF Study Area are as follows: • PCE 5 ug/L • TCE 5 ug/L • cis-1,2-DCE 70 ug/L • VC 2 ug/L [Page 2-27]
Applicable or Relevant and Appropriate Requirements:	The chemical-specific ARARs for the DCF Study Area are: • Kansas Surface Water Quality Standards (Kansas Administrative Record [KAR] § 28.16.28b) • Kansas Water Pollution Control, Antidegradation Policy (KAR § 28.16.28c(a)) • Safe Drinking Water Act(SDWA), National Primary Drinking Water Regulations (40 CFR §141, Subpart A,C,D,F, and G; and 142 Subparts A-G) • Kansas Drinking Water Standards (KAR §28.15) The location-specific ARARs for the DCF Study Area are: • Endangered Species Act of 1973 (7USC § 136 and 16USC§ 460 et seq.) • Fish and Wildlife Conservation Act (16 USC § 2901 and 2911) • Flood Control Act of 1944 (16 USC § 460) • Non-Game, Threatened or Endangered Species (KAR § 115-15) • Bald and Golden Eagle Protection Act (16 USC 668-668d) The action-specific ARARs for the DCF Study Area are: • Clean Water Act (33 USC, Chapter 26, Subchapter 1, § 1251 et seq.) • CERCLA of 1980 (42USC § 9601-9675, et seq. as amended by the SARA of 1986) • OSHA of 1970 (29USC § 651 et seq.). Includes both workplace standards (29 CFR 1910) and construction standards (29 CFR 1926) • Ambient Air Quality Standards and Air Pollution Control (KAR§ 28-19) • Water Well Contractor's License; Water Well Construction and Abandonment (KAR § 28-30) • Kansas Board of Technical Professions (KAR § 66-6 through 66-14) (2-35)

Components of the Remedy:	For the DCF Study Area, the MNA system components are groundwater wells. Contaminant concentrations will be monitored periodically to evaluate if the natural attenuation processes are reducing contaminant concentrations to below chemical-specific ARARs (MCLs). (2-45) Restrictions will limit exposure at the DCF Study Area by: • Restricting use to non-residential • Limiting public access • Prohibiting installation of drinking water wells and groundwater use in the area • Involving PWE personnel in proposed future plans for the DCFA Site (2-46)
ESD Details: (If Applicable)	N/A

APPENDIX A-3

OPERABLE UNIT 005
354 AREA SOLVENT DETECTIONS

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Decision Document Summary
Fort Riley, KS
354 Area Solvent Detections
Operational Unit OU 005
IRP Site Number FTRI-31

Decision Document Title:	Record of Decision 354 Area Solvent Detections (Operable Unity 005) at Main Post Fort Riley, Kansas, 16 June 2006
Army Signature:	Thomas T. Smith, COL, Infantry, Garrison Commander, 22 June 2006
ESD ROD Amendment Title:	Explanation of Significant Difference for the Record of Decision at the 354 Area Solvent Detections Operable Unit 005, Fort Riley, Kansas
ESD Signature:	Andrew Cole, Colonel, US Army, Garrison Commander, 23 February 2015
Regulator (support agency acceptance):	USEPA, KDHE
Public Involvement :	Proposed Plan Public Meeting: 12 July 2005 (in conjunction with the Restoration Advisory Board [RAB] meeting) - No comments made by the public during the meeting. Public Comment Period: 12 June 2005 to 12 July, 2005. No public comments submitted. [ROD, Page 2-5]
Regulatory Framework:	CERCLA NPL
Federal Facility Agreement:	USEPA ID KS6214020756, Docket No. VII-90-F-0015
Land Use:	“The 354 Site (OU 005) is part of the Fort Riley reservation and is not zoned by Geary County. North and west of the UPRR grade is a built-up area (Main Post), with building and road development. Buildings include offices, barracks, family housing units, warehouses, and maintenance facilities. South and east of the UPRR grade is the point bar of the Kansas River. This area is mainly covered with forest and vegetation; although, there is one built-up area between the UPRR grade and Marshall Avenue. The built up area consists of warehouses, several of which have been converted to office buildings. Land use at the 354 Site (OU 005) is classified under the RPMP. It is anticipated that land use activities will remain unchanged into the foreseeable future. The Main Post area to the north of the UPRR grade is classified as a National Register Historic District. The area to the south of the UPRR grade is classified as open space under the RPMP and should not see change from current land classification because it is within the active flood plain of the Kansas River where land uses must be in compliance with Executive Order

	11988 - Floodplain Management. Land use around the Building 367 and Building 354/32/DPW Compound Areas is industrial in nature, while Building 430, a fire station, is adjacent to a residential area." Future: Not anticipated to change [Pages 2-12, 2-14]
Media of Concern:	Groundwater is a medium of concern. Aquifer contamination is present within the terrace aquifer and Kansas River alluvial aquifer. [ROD, Page 2-9]
Human Receptors and Exposure Pathways of Concern	• Future Workers - Ingestion of groundwater. • Future hypothetical Adult and Child Residents - Ingestion of groundwater.
Ecological Receptors of Concern :	None
Chemicals of Concern:	PCE, cis-1,2-DCe, TCE, and benzene [ROD, Page 2-11]
Basis for Action:	"The presence of site-related contaminants in the Kansas River alluvial aquifer at levels exceeding drinking water standards (MCLs, identified as an ARAR) provides the basis for remedial action." [ROD, Page 2-18]
Remedial Action Objectives:	• Prevent the potential of degradation of the surface waters of the Kansas River by reducing levels or eliminating contaminants from the margin of the Kansas River alluvial aquifer. • Reduce contamination levels to below MCLs within the Kansas River alluvial aquifer through the use of natural and/or active remedial processes. • Reduce contaminant levels, to the extent practicable and appropriate, within the terrace aquifer, through natural and/or active remedial processes. [ROD Page 2-26]
Applicable or Relevant and Appropriate Requirements:	The chemical-specific ARARs for the 354 Site (OU 005) are: • Kansas Surface Water Quality Standards (Kansas Administrative Record [KAR] §28.16.28b) • Kansas Water Pollution Control, Antidegradation Policy (KAR §28.16.28c(a))

	• Safe Drinking Water Act (SDWA), National Primary Drinking Water Regulations (40 CFR§ 141 and 142) • Kansas Drinking Water Standards (KAR §28.15) The location-specific ARARs for the 354 Site (OU 005) are: • Archaeological and Historic Preservation Act of 1974 (16 USC § 469 et seq.) • Endangered Species Act of 1973 (7 USC § 136 and 16 USC § 460 et seq.) • Fish and Wildlife Conservation Act (16 USC §2901 and 2911) • Flood Control Act of 1944 (16 USC § 460) • National Historic Preservation Act of 1966 (16 USC § 470 et seq.) • Kansas Historic Preservations Act (KAR § 118-3) • Non-Game, Threatened or Endangered Species (KAR § 115-15) The action-specific ARARs for the 354 Site (OU 005) are: • Clean Water Act (33 USC § 1251 et seq.) • Clean Air Act (42 USC § 7401 et seq.) • CERCLA of 1980 (42 USC § 9601 et seq. as amended by the SARA of 1986) • OSHA of 1970 (29 USC § 651 et seq.). Includes both workplace standards (29 CFR 1910) and construction standards (29 CFR 1926) • Ambient Air Quality Standards and Air Pollution Control (KAR § 28-19) • Water Well Contractor's License; Water Well Construction and Abandonment (KAR §28-30) • Underground Injection Control Regulations (KAR § 28-46) • Emergency Planning and Right-to-Know (KAR § 28-65) • Kansas Board of Technical Professions (KAR § 66-6 through 66-14) [ROD, Pages 2-49 and 2-50]
Remedy Chosen:	“The selected remedy for the 354 Site (OU 005) at Fort Riley is Monitored Natural Attenuation (MNA) with institutional controls (ICs). This alternative reflects the long-term site management plan for the 354 Site in that the remedy relies on natural degradation processes already occurring at the 354 Site (OU 005) to further reduce contaminant concentrations to levels below the maximum contaminant levels (MCLs) at the Kansas River and uses ICs to restrict groundwater usage at the 354 Site. MNA is currently conducted as part of post-performance monitoring of the source in-situ treatment and soil removal action completed at the 354 Site in December 2004. ICs

	currently in place at the 354 Site are controlled by the environmental overlay of the Fort Riley Real Property Master Plan (RPMP). The RPMP is the means through which the post authorities will control and limit development and other activities on the post. This includes overall controls on land use, the issuing of excavation permits that will define and limit potential exposure for utility and grounds workers, and tactical dig permits that control potential exposure for soldiers. With this alternative, progress at the 354 Site (OU 005) will be monitored through groundwater sampling, and ICs will be implemented to restrict groundwater usage until remediation is complete. The Remedial Design/Remedial Action (RD/RA) Plan for the 354 Site (OU 005) will be completed upon ROD approval. The RD/RA Plan will include more details of the ICs and the monitoring to be conducted under the MNA approach. The primary form of ICs will be restricting the installation and use of groundwater supply wells at and down gradient of the 354 Site (OU 005). The primary control for the 354 Site (OU 005) will be to restrict use through the environmental overlay of the Fort Riley RPMP." [ROD, Page 1-2]
Clean-Up Goals:	"The remediation goal is to restore the groundwater to its beneficial use, which may include drinking water or non-domestic uses such as agricultural (livestock or irrigation)." The MCLs for the COCs at the 354 Site (OU 005) are as follows: • PCE 5 ug/L • TCE 5 ug/L • cis-l,2-DCE 70 ug/L • Benzene 5 ug/L [ROD, Page 1-3, 2-26]
ESD Details:	"The levels of tetrachloroethylene (PCE) in three monitoring wells have rebounded. Concentrations had been significantly decreasing since March 2008; however, during the March 2014 sampling event, levels in three wells increased. The PCE increase was confirmed in July 2014. The potential for risk to the alluvial aquifer of the Kansas River requires the implementation of a treatment process and further ground water sampling to address the elevated presence of PCE in the upland terrace ground water. [ESD, Page 1] "The proposed changes outlined within this ESD address these RAOs by first, sampling the wells screened within the alluvial aquifer (354-99-13C, 354-99-12C, and 354-0l-30C) to confirm that COCs are still below MCLs as stated in RAO Nos.I and 2; and secondly, to actively stimulate

	naturally-occurring MNA processes, to better meet RAO No. 3.” “The changed remedy will consist of *in situ* bioremediation of the soil and ground water in the upland terrace materials at the site followed by MNA in the terrace and alluvial aquifers in order to monitor remedial progress. *In situ* bioremediation will consist of injections of a carbon donor substrate in order to create a reducing environment in the subsurface that will promote anaerobic degradation of the PCE contamination by naturally-occurring microbial populations in the subsurface.” [ESD, Page 4]

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APPENDIX B

PUBLIC NOTICE OF FOURTH FIVE-YEAR REVIEW

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SPORTS

Luis returns to Chelsea caps

LONDON (AP) — English Premier League clubs swelled the bank accounts of continental rivals in a summer of record-breaking spending that ended Wednesday with the biggest shock of the transfer window: David Luiz's return to Chelsea.

The flamboyant Brazilian is back at Stamford Bridge after two years at Paris Saint-Germain to reinforce Chelsea's defense under new manager Antonio Conte.

While Chelsea sold the 29-year-old for around 50 million pounds ($84 million in 2014), the London club has re-signed him on a three-year contract for about 20 million pounds ($26 million) less.

That's also far lower than what was spent on the summer transfer window's biggest reunion. Italian champion Juventus banked a world-record 105 million euros ($116 million) from Manchester United for midfielder Paul Pogba's return to Old Trafford.

United was one of 13 Premier League sides to break their club records for spending on a single player since the end of last season. The 20 top-flight clubs collectively spent nearly 1.2 billion pounds ($1.5 billion) on talent in the summer, breaking the billion-pound barrier for the first time in a transfer window as they benefit from new television deals.

Over the next three years, the Premier League will make 8.3 billion pounds ($10.9 billion) from broadcasters eager to televise the most unpredictable of Europe's top leagues — a bonanza that has swelled thanks to a 70 percent upsurge in the value of domestic rights.

There is a flipside.

"All the European clubs rub their hands because when they are short of money they just ring up one of the Premier League clubs (to sell a player) to keep them going for the next two years with 10 million, 20 million — whatever it might be," Stoke chairman Peter Coates told the BBC on Wednesday. "So it's pretty good business for them."

Stoke had a relatively modest summer of spending after breaking its transfer record in the January window when it paid Portuguese club Porto 18.3 million pounds (then $26 million) for defensive midfielder Giannelli Imbula.

Negotiating with clubs on the continent for a bargain is proving tougher for Premier League chairmen like Steve Parish at Crystal Palace. The London club's record-breaking summer deal was a domestic transaction, paying Liverpool 27 million pounds ($35 million) for striker Christian Benteke.

"It's been the most difficult transfer window anybody can remember — there's kind of a wall of money," Parish said. "The other leagues basically have decided there's one price within their league and a completely different price if a Premier League club calls. The prices have gone crazy ... you find people focusing more on the domestic market."

Tottenham turned to Newcastle for its biggest summer deal, paying a reported 30 million pounds ($39 million) as the window was closing for France midfielder Moussa Sissoko.

French clubs profited from the English wealth on Wednesday, receiving about 55 million pounds ($72 million) from the Premier League. Luiz's return was preceded by Georges-Kevin Nkoudou's move from Marseille to Tottenham and Sunderland signing Didier Ndong from Lorient.

Here are some of the other key deadline-day moves across Europe:

———

ENGLAND

While splurging on new talent, Premier League clubs having sought to shed non-vital players. Offloading top earners is tough with the wealthier parent clubs, like Manchester City, often having to subsidize the wages for a player on loan.

New City coach Pep Guardiola dispatched Joe Hart, Wilfried Bony, Samir Nasri and Eliaquim Mangala on Wednesday for the rest of the season.

Hart, the England goalkeeper, is now at Italian club Torino after dropping to third choice at City. Bony joined Stoke after seeing his career stall since joining from Swansea last year. Nasri headed to Sevilla for the season after Guardiola said the French midfielder returned for preseason training "overweight." France center back Mangala also departed for Spain with Valencia.

In addition, Arsenal midfielder Jack Wilshere had to accept moving to a less prestigious club on Wednesday, heading to Bournemouth on the English Riviera for the season in a bid to revive his injury-plagued career.

Liverpool also got troubled striker Mario Balotelli off its books, with the Italian joining Nice in France.

K-STATE

CONTINUED FROM PAGE 1B

from South Dakota, the Wildcats' opener a year ago. Or Stephen F. Austin, their punching bag to kick off the 2014 season.

"It's a challenge, (but) I don't relate that to necessarily what it means to our program," Snyder said. "I think it's a great opportunity in regards to this set of young people. I have great respect for Stanford and we all know where they are in the rankings, certainly well deserved. It's obviously a challenge but it's an excellent opportunity for the young people here."

Snyder said there is no greater sense of urgency playing a marquee brand such as Stanford in Week 1, even if his players may feel differently. Every game carries the same weight to him

"I think coaches have that same sense of urgency regardless of who you're playing," he said. "You can say you'd want your players to as well and I do, but it ought to be at the heightened level regardless of who they're playing. That may be the case but I can't assure you that it always is. Maybe it is for some right now in different circumstances."

A softer opening might have been especially beneficial this season with Kansas State quarterback Jesse Ertz and safety Dante Barnett returning from season-ending injuries.

Ertz was announced as the starter on Monday, completing his comeback from a torn ACL that he sustained in the first game last season. He will try to turn around an offense that was ninth in the Big 12 in passing offense a year ago, and shuffled through so many different faces under center that wide receiver Kody Cook was eventually pressed into duty.

Barnett will be relied upon just as much on defense, where the senior will try to direct a group that allowed more than 450 yards and 31.5 points per game last season.

"We are going on the road and playing one of the Heisman finalists from last year," he said. "We are also playing one of the top-10 teams in the country, so I cannot wait for the atmosphere."

CHIEFS

CONTINUED FROM PAGE 1B

Mike Pennel suspended the first four weeks of the regular season.

After starters Mike Daniels and Letroy Guion, fourth-rounder Dean Lowry may need to contribute right away.

The defense offers the biggest intrigue in Kansas City, too.

The late trade with San Francisco for cornerback Kenneth Acker means competition is tight for jobs in the secondary. The Chiefs have second-year pro Steven Nelson and rookies KeiVarae Russell, Eric Murray and D.J. White along with Marcus Cooper and starters Phillip Gaines and Marcus Peters.

"I like the competition from the young guys," Chiefs safety Ron Parker said. "They do a good job of coming out here every day and competing against each other, going out there and making it hard against the offense. So that's all we're asking for young guys to do."

In the linebacker group, the absence of Justin Houston as he recovers from surgery to his ACL and the loss of Josh Mauga to season-ending hip surgery this week leave a substantial void.

Ramik Wilson, Justin March, and Dadi Nicolas are all trying to prove they have something to offer.

"We're trying to see what everybody can do," Chiefs defensive coordinator Bob Sutton said. "We're trying to get as many evaluations as we can on these guys and give them a chance to go against the first unit of whoever you're playing and kind of see it as close to game as you can on a more limited basis."

Classifieds

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Public Notices 310

PUBLIC NOTICE
FORT RILEY, KANSAS
ANNOUNCES FIVE-YEAR REVIEW

On behalf of Fort Riley, the U.S. Army Corps of Engineers is conducting the fourth Five-Year Review of cleanup actions associated with four sites, designated as Operable Units (OUs), at Fort Riley, Kansas: 001, 003, 005, and 008.

Interested members of the public are invited to provide input for the Five-Year Review. The Five-Year Review will cover the Remedial Action Objectives for each of the OUs to determine if they remain protective of human health and environment.

Example questions on which you might consider providing input include:
* What are your overall impressions of the sites?
* Have site operations had an impact on the surrounding community?
* Are there any community concerns regarding the sites or their operation and administration?
* Are you aware of any events, incidents, or activities at the sites such as vandalism, trespassing, or emergency responses from local or installation authorities?
* Do you feel well informed about site activities and programs?
* Do you have comments, suggestions, or recommendations regarding site management or operation?

Descriptions of each OU are provided below:

OU001: Southwest Funston Landfill has vinyl chloride concentrations in groundwater that are below drinking water Maximum Contaminant Levels (MCLs). The implemented remedy includes repair and maintenance of the landfill cover and riverbank stabilization structure, annual groundwater monitoring and institutional controls (i.e.: fences, signs). The site was determined to be functionally stable and to have reached the site completion milestone under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

OU003: Dry Cleaning Facilities Area has chlorinated solvents in groundwater. A pilot study that addressed soil contamination using excavation and land farming was conducted in 2006. Groundwater contamination was also addressed through enhanced bioremediation and chemical oxidation.

OU005: 354 Area Solvent Detections has chlorinated solvents and benzene in groundwater; however, most contaminants have fallen below their respective MCLs. The original remedy included annual groundwater monitoring for natural attenuation effectiveness and institutional controls. In 2015, in situ treatment and ground water sampling was instituted to account for the original remedy not functioning as intended.

OU008: Sherman Heights Small Arms Range has not been included in previous Five-Year Reviews, so this will be the first evaluation of the protectiveness of the remedy. Lead is the primary contaminant at this site. The selected remedy is Land Use Controls (LUCs) which will include public education, legal restrictions on future land use, physical access restrictions (fencing and signage), and long term monitoring/maintenance. LUCs will be required indefinitely or until such a time as it is determined that contamination levels are below the remedial goal of 400 milligrams per kilogram (mg/kg) for lead. The site will reach Remedy in Place (RIP) under CERCLA by 2018.

For more information on past and ongoing environmental cleanup at Fort Riley, the Administrative Record can be viewed at:

Directorate of Public Works
Environmental Division
1MNW-RLY- PWE
407 Pershing Court
Fort Riley, Kansas 66442-6016
(785) 239-8619
Monday - Friday, 9 AM to 4 PM

Comments or questions related to this Five-Year Review can be submitted by February 1, 2017 to Dr. Richard Shields of Fort Riley at the address provided above. Questions or comments can also be submitted by contacting Dr. Shields at (785) 239-3194 or the U.S. Army Corps of Engineers at (502) 315-6773. A public notice announcing completion of the review and the location of the final Five-Year Review Report is anticipated to be released in September 2017.

A3055
09/01/16

Public Notices 310

ADVERTISEMENT FOR BIDS
Request for Bid -2017 Police Sport Utility Vehicle
City of Junction City, Kansas

The City of Junction City, Kansas will receive bids through the City Clerk, by 3:00 p.m. September 16th, 2016 at City Hall, 700 N. Jefferson St, Junction City, KS 66441, for Three (3) New Police Sport Utility Vehicle, 4 x 4, Full Size, 1/2 ton, 4 door, 5 passenger, Black in Color. Bids shall be directed to the City Clerk, securely sealed and endorsed upon the outside wrapper with a brief statement for the summary as to the bid is made. The City reserves the right to reject any or all bids, and to waive any information in the bidding. Bid specifications are available at the office of the Junction City Chief of Police or at the City of Junction City website at www.junctioncity-ks.gov. Questions regarding the bids should be directed to Lt. Scott Popovich, Junction City Police Department Building and Facilities Manager at (785) 762-5912.

A3058
Sept. 1, 2016

su|do|ku

					3		2	1
5		4						
	3						9	
6						1		
9	8			6				
					1		5	8
3			4	5	9	8		
7			3				4	
					8			5

Level: Intermediate

What Is su|do|ku?

The objective of the game is to fill all the blank squares in a game with the correct numbers. There are three very simple constraints to follow. In a 9 by 9 square sudoku game:
- Every row of 9 numbers must include all digits 1 through 9 in any order
- Every column of 9 numbers must include all digits 1 through 9 in any order
- Every 3 by 3 subsection of the 9 by 9 square must include all digits 1 through 9

Wednesday's Answers

6	2	1	7	5	9	3	4	8
9	4	5	3	8	2	6	7	1
8	7	3	4	6	1	5	2	9
4	8	7	1	3	5	2	9	6
5	1	2	6	9	4	7	8	3
3	9	6	2	7	8	1	5	4
2	5	9	8	1	6	4	3	7
7	6	4	9	2	3	8	1	5
1	3	8	5	4	7	9	6	2

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APPENDIX C

SITE INSPECTION CHECKLISTS

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APPENDIX C-1

OPERABLE UNIT 001
SOUTHWEST FUNSTON LANDFILL

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Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Ft. Riley, OU 001, South Fnston LF	**Date of inspection:** 14 DEC 2016
Location and Region: Junction City, Ky Region 9	**EPA ID:** KS6214020756
Agency, office, or company leading the five-year review: US ARMY	**Weather/temperature:** overcast, windy Temp around 30°F

Remedy Includes: (Check all that apply)

✓ Landfill cover/containment
✓ Access controls
✓ Institutional controls
Groundwater pump and treatment
Surface water collection and treatment
Other

Monitored natural attenuation
Groundwater containment
Vertical barrier walls

Attachments: ✓ Inspection team roster attached ✓ Site map attached See report

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Dr. Richard Shields (Name) Program Manager (Title) Nov 16, 2011 (Date)
Interviewed ✓ at site at office by phone Phone no.
Problems, suggestions; Report attached see report text

2. **O&M staff** N/A (Name) (Title) (Date)
Interviewed at site at office by phone Phone no.
Problems, suggestions; Report attached

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency USEPA
Contact AMER SAFADI Remedial Project Mgr 14 Dec 2016 913-551-7825
Name Title Date Phone no.
Problems; suggestions; Report attached See report text

Agency KDHE
Contact Kelly Peterson Project Mgr 14 DEC 2016 785-291-3245
Name Title Date Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name Title Date Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name Title Date Phone no.
Problems; suggestions; Report attached

4. **Other interviews** (optional) Report attached.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	[✓ O&M manual]	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ As-built drawings]	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ Maintenance logs]	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks ______			
2.	**Site-Specific Health and Safety Plan**	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ Contingency plan/emergency response plan]	[✓ Readily available]	Up to date	N/A
	Remarks ______			
3.	**O&M and OSHA Training Records**	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks ______			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	[✓ N/A]
	Effluent discharge	Readily available	Up to date	[✓ N/A]
	Waste disposal, POTW	Readily available	Up to date	[✓ N/A]
	Other permits ______	Readily available	Up to date	[✓ N/A]
	Remarks ______			
5.	**Gas Generation Records**	Readily available	Up to date	[✓ N/A]
	Remarks ______			
6.	**Settlement Monument Records**	Readily available	Up to date	[✓ N/A]
	Remarks ______			
7.	**Groundwater Monitoring Records**	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks ______			
8.	**Leachate Extraction Records**	Readily available	Up to date	[✓ N/A]
	Remarks ______			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	[✓ N/A]
	Water (effluent)	Readily available	Up to date	[✓ N/A]
	Remarks ______			
10.	**Daily Access/Security Logs**	Readily available	Up to date	[✓ N/A]
	Remarks ______			

IV. O&M COSTS

1. **O&M Organization**
State in-house
Contractor for State
PRP in-house
Contractor for PRP
Federal Facility in-house
[✓ Contractor for Federal Facility]
Other

2. **O&M Cost Records**
[✓ Readily available]
Up to date
[✓ Funding mechanism/agreement in place]
Original O&M cost estimate $0.94/yr Breakdown attached

Total annual cost by year for review period if available

From 01 OCT 2012 To 30 Sept 2013 $62,291 Breakdown attached
From 01 OCT 2013 To 30 Sept 2014 $30,049 Breakdown attached
From 01 OCT 2014 To 30 Sept 2015 $29,903 Breakdown attached
From 01 Oct 2015 To 30 Sep 2016 $36,320 Breakdown attached
From 01 Oct 2016 To 30 Sep 2017 $38,283 Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: Higher cost associated w/ L/F repair

V. ACCESS AND INSTITUTIONAL CONTROLS [✓ Applicable] N/A

A. Fencing

1. **Fencing damaged** Location shown on site map [✓ Gates secured] N/A
Remarks

B. Other Access Restrictions

1. [✓ **Signs and other security measures**] Location shown on site map N/A
Remarks Signs at entrance, good condition

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented Yes [✓ No] N/A
Site conditions imply ICs not being fully enforced Yes [✓ No] N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Security Patrols and Inspections
Frequency Daily Security patrols, annual inspections
Responsible party/agency Fort Riley
Contact ______ Name ______ Title ______ Date ______ Phone no.

Reporting is up-to-date [✓ Yes] No N/A
Reports are verified by the lead agency [✓ Yes] No N/A

Specific requirements in deed or decision documents have been met [✓ Yes] No N/A
Violations have been reported Yes [✓ No] N/A
Other problems or suggestions: Report attached
*/ ICs recorded in Fort Riley real property management plan, and land use control implementation plan

2. **Adequacy** [✓ ICs are adequate] ICs are inadequate N/A
Remarks

D. General

1. **Vandalism/trespassing** Location shown on site map [✓ No vandalism evident]
Remarks

2. **Land use changes on site** N/A
Remarks No changes noted

3. **Land use changes off site** N/A
Remarks No changes noted

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map [✓ Roads adequate] N/A
Remarks unpaved road throught site requires all wheel drive

B. Other Site Conditions

Remarks None noted

VII. LANDFILL COVERS [✓ Applicable] N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent Depth
Remarks No settlement noted

2. **Cracks** Location shown on site map [✓ Cracking not evident]
Lengths Widths Depths
Remarks No cracking noted

3. **Erosion** Location shown on site map [✓ Erosion not evident]
Areal extent Depth
Remarks No erosion noted

4. **Holes** Location shown on site map [✓ Holes not evident]
Areal extent Depth
Remarks No holes noted

5. **Vegetative Cover** [✓ Grass] [✓ Cover properly established] [✓ No signs of stress]
Trees/Shrubs (indicate size and locations on a diagram)
Remarks

6. **Alternative Cover (armored rock, concrete, etc.)** [✓ N/A]
Remarks

7. **Bulges** Location shown on site map [✓ Bulges not evident]
Areal extent Height
Remarks

8. **Wet Areas/Water Damage** [✓ Wet areas/water damage not evident]

Wet areas Location shown on site map Areal extent__________

Ponding Location shown on site map Areal extent__________

Seeps Location shown on site map Areal extent__________

Soft subgrade Location shown on site map Areal extent__________

Remarks____

9. **Slope Instability** Slides Location shown on site map [✓ No evidence of slope instability]

Areal extent__________

Remarks____

B. Benches Applicable [✓ N/A]

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map [✓ N/A or okay]

Remarks____

2. **Bench Breached** Location shown on site map N/A or okay

Remarks____

3. **Bench Overtopped** Location shown on site map N/A or okay

Remarks____

C. Letdown Channels Applicable N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement

Areal extent__________ Depth__________

Remarks____

2. **Material Degradation** Location shown on site map No evidence of degradation

Material type__________ Areal extent__________

Remarks____

3. **Erosion** Location shown on site map No evidence of erosion

Areal extent__________ Depth__________

Remarks____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ No obstructions
Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations Applicable [✓ N/A]

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks____
____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks____
____

E. Gas Collection and Treatment Applicable [✓ N/A]

1. **Gas Treatment Facilities**
Flaring Thermal destruction Collection for reuse
Good condition Needs Maintenance
Remarks____

2. **Gas Collection Wells, Manifolds and Piping**
Good condition Needs Maintenance
Remarks____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
Good condition Needs Maintenance N/A
Remarks____

F. Cover Drainage Layer Applicable [✓ N/A]

1. **Outlet Pipes Inspected** Functioning N/A
Remarks____

2. **Outlet Rock Inspected** Functioning N/A
Remarks____

G. Detention/Sedimentation Ponds Applicable [✓ N/A]

1. **Siltation** Areal extent__________ Depth__________ N/A
Siltation not evident
Remarks____

2. **Erosion** Areal extent__________ Depth__________
Erosion not evident
Remarks____

3. **Outlet Works** Functioning N/A
Remarks____

4. **Dam** Functioning N/A
Remarks____

H. Retaining Walls Applicable [✓ N/A]

1. **Deformations** Location shown on site map Deformation not evident
Horizontal displacement________ Vertical displacement________
Rotational displacement________
Remarks________

2. **Degradation** Location shown on site map Degradation not evident
Remarks________

I. Perimeter Ditches/Off-Site Discharge [✓ Applicable] N/A

1. **Siltation** Location shown on site map Siltation not evident
Areal extent________ Depth________
Remarks Not observed during site inspection in Dec. May 2016 inspection did not note siltation

2. **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent________ Type________
Remarks May 2016 inspection indicated ~~no~~ vegetation does not impede flow

3. **Erosion** Location shown on site map [✓ Erosion not evident]
Areal extent________ Depth________
Remarks May 2016 inspection did not note erosion

4. **Discharge Structure** Functioning [✓ N/A]
Remarks________

VIII. VERTICAL BARRIER WALLS Applicable [✓ N/A]

1. **Settlement** Location shown on site map Settlement not evident
Areal extent________ Depth________
Remarks________

2. **Performance Monitoring** Type of monitoring________
Performance not monitored
Frequency________ Evidence of breaching
Head differential________
Remarks________

IX. GROUNDWATER/SURFACE WATER REMEDIES Applicable [✓ N/A]

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
Good condition All required wells properly operating Needs Maintenance N/A
Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable [✓ N/A]

1. **Collection Structures, Pumps, and Electrical**
Good condition Needs Maintenance
Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks

C. Treatment System Applicable [✓ N/A]

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
Air stripping Carbon adsorbers
Filters ______
Additive (*e.g.*, chelation agent, flocculent) ______
Others ______
Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually ______
Quantity of surface water treated annually ______
Remarks ______

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A Good condition Needs Maintenance
Remarks ______

3. **Tanks, Vaults, Storage Vessels**
N/A Good condition Proper secondary containment Needs Maintenance
Remarks ______

4. **Discharge Structure and Appurtenances**
N/A Good condition Needs Maintenance
Remarks ______

5. **Treatment Building(s)**
N/A Good condition (esp. roof and doorways) Needs repair
Chemicals and equipment properly stored
Remarks ______

6. **Monitoring Wells** (pump and treatment remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks ______

D. Monitoring Data

1. Monitoring Data
✓ Is routinely submitted on time ✓ Is of acceptable quality

2. Monitoring data suggests:
✓ Groundwater plume is effectively contained ✓ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
[✓ Properly secured/locked] [✓ Functioning] [✓ Routinely sampled] [✓ Good condition]
[✓ All required wells located] • Needs Maintenance • N/A
Remarks May 2016 inspection indicated no concers

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

OU 001 - South Funston Landfill cover appears to be in good condition and operating as intended

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

No issues observed.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

None

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Further monitoring does not appear to be warranted based on monitoring data since 2001

APPENDIX C-2

OPERABLE UNIT 003
DRY CLEANING FACILITIES AREA

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Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Ft. Riley, OU003, Drycleaning Facilities Area	**Date of inspection:** 14 December 2016
Location and Region: Junction City, KS, Region 9	**EPA ID:** KS6214020756
Agency, office, or company leading the five-year review: US Army	**Weather/temperature:** Overcast, windy Temperature around 30°F

Remedy Includes: (Check all that apply)

Landfill cover/containment
Access controls
[✓ Institutional controls]
Groundwater pump and treatment
Surface water collection and treatment
Other ______

[✓ Monitored natural attenuation]
[✓ Groundwater containment]
Vertical barrier walls

Attachments: [✓ Inspection team roster attached] [✓ Site map attached]

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Dr. Richard Shields — Program Mgr. — 16 Nov 2011
   Name / Title / Date
   Interviewed [✓ at site] at office by phone Phone no. ______
   Problems, suggestions; Report attached See report.

2. **O&M staff** N/A ______ ______
   Name / Title / Date
   Interviewed at site at office by phone Phone no. ______
   Problems, suggestions; Report attached ______

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency USEPA
Contact Amer Safadi (Name) | Remedial Program Mgr (Title) | 14 Dec 2016 (Date) | 913-551-7825 (Phone no.)
Problems; suggestions; Report attached See report

Agency KDHE
Contact Kelly Peterson (Name) | Project Manager (Title) | 14 Dec 2016 (Date) | 785-291-3245 (Phone no.)
Problems; suggestions; Report attached

Agency
Contact Name | Title | Date | Phone no.
Problems; suggestions; Report attached

Agency
Contact Name | Title | Date | Phone no.
Problems; suggestions; Report attached

4. **Other interviews** (optional) Report attached.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	[✓ O&M manual]	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ As-built drawings]	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ Maintenance logs]	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks__________			
2.	[✓ **Site-Specific Health and Safety Plan**]	[✓ Readily available]	[✓ Up to date]	N/A
	[✓ Contingency plan/emergency response plan]	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks__________			
3.	**O&M and OSHA Training Records**	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks__________			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	[✓ N/A]
	Effluent discharge	Readily available	Up to date	[✓ N/A]
	Waste disposal, POTW	Readily available	Up to date	[✓ N/A]
	Other permits__________	Readily available	Up to date	[✓ N/A]
	Remarks__________			
5.	**Gas Generation Records**	Readily available	Up to date	[✓ N/A]
	Remarks__________			
6.	**Settlement Monument Records**	Readily available	Up to date	[✓ N/A]
	Remarks__________			
7.	**Groundwater Monitoring Records**	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks__________			
8.	**Leachate Extraction Records**	Readily available	Up to date	[✓ N/A]
	Remarks__________			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	[✓ N/A]
	Water (effluent)	Readily available	Up to date	[✓ N/A]
	Remarks__________			
10.	**Daily Access/Security Logs**	Readily available	Up to date	[✓ N/A]
	Remarks__________			

IV. O&M COSTS

1. **O&M Organization**

State in-house
PRP in-house
Federal Facility in-house
Other

Contractor for State
Contractor for PRP
[✓ Contractor for Federal Facility]

2. **O&M Cost Records**

[✓ Readily available] [✓ Up to date]
Funding mechanism/agreement in place
Original O&M cost estimate $ 0.94 Million/year Breakdown attached

Total annual cost by year for review period if available

From ____ To ____ ____ Breakdown attached
Date Date Total cost
From 01 oct 2013 To 30 Sep 2014 $19,674 Breakdown attached
Date Date Total cost
From 01 oct 2014 To 30 Sep 2015 $18,099 Breakdown attached
Date Date Total cost
From 01 oct 2015 To 30 Sep 2016 $ Not provided Breakdown attached
Date Date Total cost
From 01 oct 2016 To 30 Sep 2017 $ 16,510 Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

V. ACCESS AND INSTITUTIONAL CONTROLS [✓ Applicable] N/A

A. Fencing

1. **Fencing damaged** Location shown on site map Gates secured [✓ N/A]

Remarks

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map [✓ N/A]

Remarks

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes [✓ No] N/A

Site conditions imply ICs not being fully enforced — Yes [✓ No] N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Security patrols and inspections

Frequency daily/Annual

Responsible party/agency Fort Riley

Contact ____ Name ____ Title ____ Date ____ Phone no.

Reporting is up-to-date — [✓ Yes] No N/A

Reports are verified by the lead agency — [✓ Yes] No N/A

Specific requirements in deed or decision documents have been met — [✓ Yes] No N/A

Violations have been reported — Yes [✓ No] N/A

Other problems or suggestions: Report attached

None

2. **Adequacy** — [✓ ICs are adequate] ICs are inadequate N/A

Remarks

D. General

1. **Vandalism/trespassing** — Location shown on site map [✓ No vandalism evident]

Remarks

2. **Land use changes on site** N/A

Remarks None noted

3. **Land use changes off site** N/A

Remarks None noted

VI. GENERAL SITE CONDITIONS

A. Roads Applicable [✓ N/A]

1. **Roads damaged** — Location shown on site map Roads adequate N/A

Remarks

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS

Applicable [✓ N/A]

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent Depth
   Remarks

2. **Cracks** Location shown on site map Cracking not evident
   Lengths Widths Depths
   Remarks

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent Depth
   Remarks

4. **Holes** Location shown on site map Holes not evident
   Areal extent Depth
   Remarks

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent Height
   Remarks

8. **Wet Areas/Water Damage** Wet areas/water damage not evident
Wet areas Location shown on site map Areal extent___
Ponding Location shown on site map Areal extent___
Seeps Location shown on site map Areal extent___
Soft subgrade Location shown on site map Areal extent___
Remarks___

9. **Slope Instability** Slides Location shown on site map No evidence of slope instability
Areal extent___
Remarks___

B. Benches Applicable N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map N/A or okay
Remarks___

2. **Bench Breached** Location shown on site map N/A or okay
Remarks___

3. **Bench Overtopped** Location shown on site map N/A or okay
Remarks___

C. Letdown Channels Applicable N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement
Areal extent___ Depth___
Remarks___

2. **Material Degradation** Location shown on site map No evidence of degradation
Material type___ Areal extent___
Remarks___

3. **Erosion** Location shown on site map No evidence of erosion
Areal extent___ Depth___
Remarks___

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type____________________ No obstructions
Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks____
____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks____
____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
Flaring Thermal destruction Collection for reuse
Good condition Needs Maintenance
Remarks____
____

2. **Gas Collection Wells, Manifolds and Piping**
Good condition Needs Maintenance
Remarks____
____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
Good condition Needs Maintenance N/A
Remarks____
____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
Remarks____
____

2. **Outlet Rock Inspected** Functioning N/A
Remarks____
____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent______________ Depth____________ N/A
Siltation not evident
Remarks____
____

2. **Erosion** Areal extent______________ Depth____________
Erosion not evident
Remarks____
____

3. **Outlet Works** Functioning N/A
Remarks____
____

4. **Dam** Functioning N/A
Remarks____
____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
Horizontal displacement__________ Vertical displacement__________
Rotational displacement__________
Remarks____
____

2. **Degradation** Location shown on site map Degradation not evident
Remarks____
____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
Areal extent__________ Depth__________
Remarks____
____

2. **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent__________ Type__________
Remarks____
____

3. **Erosion** Location shown on site map Erosion not evident
Areal extent__________ Depth__________
Remarks____
____

4. **Discharge Structure** Functioning N/A
Remarks____
____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
Areal extent__________ Depth__________
Remarks____
____

2. **Performance Monitoring** Type of monitoring__________
Performance not monitored
Frequency__________ Evidence of breaching
Head differential__________
Remarks____
____

IX. GROUNDWATER/SURFACE WATER REMEDIES [✓ Applicable] N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable [✓ N/A]

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance [✓ N/A]
   Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** N/A
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment** N/A
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable [✓ N/A]

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

C. Treatment System Applicable [✓ N/A]

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
Air stripping Carbon adsorbers
Filters ____________________
Additive (*e.g.*, chelation agent, flocculent) ____________________
Others ____________________
Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually ____________________
Quantity of surface water treated annually ____________________
Remarks ____________________

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A Good condition Needs Maintenance
Remarks ____________________

3. **Tanks, Vaults, Storage Vessels**
N/A Good condition Proper secondary containment Needs Maintenance
Remarks ____________________

4. **Discharge Structure and Appurtenances**
N/A Good condition Needs Maintenance
Remarks ____________________

5. **Treatment Building(s)**
N/A Good condition (esp. roof and doorways) Needs repair
Chemicals and equipment properly stored
Remarks ____________________

6. **Monitoring Wells** (pump and treatment remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks ____________________

D. Monitoring Data

1. Monitoring Data
✓ Is routinely submitted on time ✓ Is of acceptable quality

2. Monitoring data suggests:
✓ Groundwater plume is effectively contained ✓ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
[✓ Properly secured/locked] [✓ Functioning] [✓ Routinely sampled] [✓ Good condition]
[✓ All required wells located] Needs Maintenance N/A
Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

OU 003 - the remedy appears to be functioning as intended

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M is adequate

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None

APPENDIX C-3

OPERABLE UNIT 005
354 AREA SOLVENT DETECTIONS

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Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Ft Riley, OU 005 Area 354 Solvent

Date of inspection: 14 Dec 2014

Location and Region: Junction City, KS, Region 9

EPA ID:

Agency, office, or company leading the five-year review: U. S. Army

Weather/temperature: Overcast Windy Temp around 30°F

Remedy Includes: (Check all that apply)

Landfill cover/containment
Access controls
✓ Institutional controls
Groundwater pump and treatment
Surface water collection and treatment
Other

✓ Monitored natural attenuation
✓ Groundwater containment
Vertical barrier walls

Attachments: ✓ Inspection team roster attached ✓ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Dr. Richard Shields Program Mgr since 16 NOV 2011
Name Title Date
Interviewed ✓ at site at office by phone Phone no.
Problems, suggestions; Report attached

2. **O&M staff** N/A
Name Title Date
Interviewed at site at office by phone Phone no.
Problems, suggestions; Report attached

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency USEPA
Contact AMER Safadi — Remedial Project Mgr. — 14 Dec 2016 — 913 551-7825
Name — Title — Date — Phone no.
Problems; suggestions; Report attached See report

Agency KDHE
Contact Kelly Peterson — Project Mgmr — 14 Dec 2016 — 785-291-3245
Name — Title — Date — Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name — Title — Date — Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name — Title — Date — Phone no.
Problems; suggestions; Report attached

4. **Other interviews** (optional) Report attached.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	[✓ Readily available]	[✓ Up to date]	N/A
	As-built drawings	[✓ Readily available]	[✓ Up to date]	N/A
	Maintenance logs	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	[✓ Readily available]	[✓ Up to date]	N/A
	Contingency plan/emergency response plan	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	[✓ Up to date]	[✓ N/A]
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	[✓ N/A]
	Effluent discharge	Readily available	Up to date	[✓ N/A]
	Waste disposal, POTW	Readily available	Up to date	[✓ N/A]
	Other permits	Readily available	Up to date	[✓ N/A]
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
7.	**Groundwater Monitoring Records**	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	[✓ N/A]
	Water (effluent)	Readily available	Up to date	[✓ N/A]
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	[✓ N/A]
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house
PRP in-house
Federal Facility in-house
Contractor for State
Contractor for PRP
[✓ Contractor for Federal Facility]
Other____

2. **O&M Cost Records**

Readily available
Up to date
Funding mechanism/agreement in place
Original O&M cost estimate__________________ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
			Breakdown attached
01 Oct 2013	30 Sep 2014	$38,492	Breakdown attached
01 Oct 2014	30 Sep 2015	$38,492	Breakdown attached
01 Oct 2015	30 Sep 2016	$33,580	Breakdown attached
01 Oct 2016	30 Sep 2017	$30,43	Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

V. ACCESS AND INSTITUTIONAL CONTROLS [✓ Applicable] N/A

A. Fencing

1. **Fencing damaged** Location shown on site map Gates secured [✓ N/A]

Remarks____

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map [✓ N/A]

Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented Yes [✓ No] N/A
Site conditions imply ICs not being fully enforced Yes [✓ No] N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Security Patrols and Inspections
Frequency daily and yearly
Responsible party/agency Ft Riley
Contact ____ Name ____ Title ____ Date ____ Phone no.

Reporting is up-to-date [✓ Yes] No N/A
Reports are verified by the lead agency [✓ Yes] No N/A

Specific requirements in deed or decision documents have been met [✓ Yes] No N/A
Violations have been reported Yes [✓ No] N/A
Other problems or suggestions: Report attached
None

2. **Adequacy** [✓ ICs are adequate] ICs are inadequate N/A
Remarks

D. General

1. **Vandalism/trespassing** Location shown on site map [✓ No vandalism evident]
Remarks

2. **Land use changes on site** [✓ N/A]
Remarks

3. **Land use changes off site** [✓ N/A]
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads Applicable [✓ N/A]

1. **Roads damaged** Location shown on site map Roads adequate N/A
Remarks

B. Other Site Conditions

Remarks N/A

VII. LANDFILL COVERS

Applicable [✓ N/A]

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent________ Depth________
Remarks________

2. **Cracks** Location shown on site map Cracking not evident
Lengths________ Widths________ Depths________
Remarks________

3. **Erosion** Location shown on site map Erosion not evident
Areal extent________ Depth________
Remarks________

4. **Holes** Location shown on site map Holes not evident
Areal extent________ Depth________
Remarks________

5. **Vegetative Cover** Grass Cover properly established No signs of stress
Trees/Shrubs (indicate size and locations on a diagram)
Remarks________

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
Remarks________

7. **Bulges** Location shown on site map Bulges not evident
Areal extent________ Height________
Remarks________

8. **Wet Areas/Water Damage** Wet areas/water damage not evident

Wet areas Location shown on site map Areal extent______________

Ponding Location shown on site map Areal extent______________

Seeps Location shown on site map Areal extent______________

Soft subgrade Location shown on site map Areal extent______________

Remarks____

____

9. **Slope Instability** Slides Location shown on site map No evidence of slope instability

Areal extent______________

Remarks____

____

B. Benches Applicable N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map N/A or okay

Remarks____

____

2. **Bench Breached** Location shown on site map N/A or okay

Remarks____

____

3. **Bench Overtopped** Location shown on site map N/A or okay

Remarks____

____

C. Letdown Channels Applicable N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement

Areal extent______________ Depth____________

Remarks____

____

2. **Material Degradation** Location shown on site map No evidence of degradation

Material type______________ Areal extent____________

Remarks____

____

3. **Erosion** Location shown on site map No evidence of erosion

Areal extent______________ Depth____________

Remarks____

____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ No obstructions
Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks____
____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks____
____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks____
____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks____
   ____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks____
   ____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks____
   ____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks____
   ____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks____
   ____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent______________ Depth____________ N/A
   Siltation not evident
   Remarks____
   ____

2. **Erosion** Areal extent______________ Depth____________
   Erosion not evident
   Remarks____
   ____

3. **Outlet Works** Functioning N/A
   Remarks____
   ____

4. **Dam** Functioning N/A
   Remarks____
   ____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
Horizontal displacement__________ Vertical displacement_____________
Rotational displacement__________
Remarks____
____

2. **Degradation** Location shown on site map Degradation not evident
Remarks____
____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
Areal extent____________ Depth__________
Remarks____
____

2. **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent____________ Type__________
Remarks____
____

3. **Erosion** Location shown on site map Erosion not evident
Areal extent____________ Depth__________
Remarks____
____

4. **Discharge Structure** Functioning N/A
Remarks____
____

VIII. VERTICAL BARRIER WALLS Applicable [✓ N/A]

1. **Settlement** Location shown on site map Settlement not evident
Areal extent____________ Depth__________
Remarks____
____

2. **Performance Monitoring** Type of monitoring______________________
Performance not monitored
Frequency___________________________ Evidence of breaching
Head differential______________________
Remarks____
____

IX. GROUNDWATER/SURFACE WATER REMEDIES [✓ Applicable] N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable [✓ N/A]

1. **Pumps, Wellhead Plumbing, and Electrical**
Good condition All required wells properly operating Needs Maintenance N/A
Remarks__________

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks__________

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks__________

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable [✓ N/A]

1. **Collection Structures, Pumps, and Electrical**
Good condition Needs Maintenance
Remarks__________

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks__________

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks__________

C. Treatment System Applicable [✓ N/A]

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
Air stripping Carbon adsorbers
Filters
Additive (*e.g.*, chelation agent, flocculent)
Others
Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually
Quantity of surface water treated annually
Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A Good condition Needs Maintenance
Remarks

3. **Tanks, Vaults, Storage Vessels**
N/A Good condition Proper secondary containment Needs Maintenance
Remarks

4. **Discharge Structure and Appurtenances**
N/A Good condition Needs Maintenance
Remarks

5. **Treatment Building(s)**
N/A Good condition (esp. roof and doorways) Needs repair
Chemicals and equipment properly stored
Remarks

6. **Monitoring Wells** (pump and treatment remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks

D. Monitoring Data

1. Monitoring Data
[✓ Is routinely submitted on time] [✓ Is of acceptable quality]

2. Monitoring data suggests:
[✓ Groundwater plume is effectively contained] [✓ Contaminant concentrations are declining]

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
[✓ Properly secured/locked] [✓ Functioning] [✓ Routinely sampled] [✓ Good condition]
[✓ All required wells located] Needs Maintenance N/A
Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

OU 005 = Remedy appears to be functioning as intended

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

None

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None identified

APPENDIX D
PHOTOGRAPHS

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APPENDIX D-1

OPERABLE UNIT 001
SOUTHWEST FUNSTON LANDFILL

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Photo 1

Description: Entrance to OU 001 with locked gate

Photo 2

Description: Gravel road through central portion of OU 001

Photo 3

Description: Signage at entrance to OU 001

Photo 4

Description: Typical vegetation of native grasses on landfill cover

APPENDIX D-2

OPERABLE UNIT 003
DRY CLEANING FACILITIES AREA

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Photo 5

Description: Former DCFA building sites looking south across Custer Avenue (AOCs 1 and 2)

Photo 6

Description: DFCA looking west toward AOC 3

Photo 7

Description: Monitoring Well DCF02-42 at AOC 3

Photo 8

Description: Typical vegetation on the south side of the UPRR railroad

APPENDIX D-3

OPERABLE UNIT 005
354 AREA SOLVENT DETECTIONS

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Photo 9

Description: Monitoring Well 354-01-26 upgradient of source area

Photo 10

Description: LTM Monitoring Well 354-01-27. Building 367 in background

Photo 11

Description: LTM Monitoring Well 354-99-09

Photo 12

Description: LTM Monitoring Well TSO292-02

APPENDIX E
INTERVIEWS

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Five-Year Review
Interview Record

Fort Riley, Junction City, Kansas

Southwest Funston Landfill, OU001
Dry Cleaning Facilities Area, OU003
354 Area Solvent Detections, OU005
OB/OD Ground (Range 16), OU006
Sherman Heights Small Arms Range, OU008

Name: Amer Safadi Date: October 25, 2016

Title: Remedial Project Manager

Organization: EPA

Telephone No: 913-551-7825

E-Mail Address: safadi.amer@epa.gov

1. What is your overall impression of the program?

   Good.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the sites? If so, please give purpose and results.

   Yes, site visits and reporting are conducted periodically.

3. Have there been any complaints, violations, or other incidents related to the sites requiring a response by your office? If so, please give details of the events and results of the responses.

   Not currently.

4. Do you feel well informed about the activities and progress related to the sites?

   Yes.

5. What effects have site operations had on the surrounding community?

   NOT MUCH TO MY KNOWLODGE

6. Are you aware of any community concerns regarding the site or its operation and administration?

   No.

7. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

   No.

8. Do you have any comments, suggestions, or recommendations regarding management or operation of the sites?

   No.

Five-Year Review
Interview Record

Fort Riley, Junction City, Kansas

Southwest Funston Landfill, OU001
Dry Cleaning Facilities Area, OU003
354 Area Solvent Detections, OU005
OB/OD Ground (Range 16), OU006
Sherman Heights Small Arms Range, OU008

Name:Kelly Peterson Date: 12Dec2016

Title: Professional Geologist

Organization: KDHE/BER

Telephone No: (785)291-3245

E-Mail Address: Kelly.Peterson@KS.gov

1. What is your overall impression of the program?

Positive. The Army has been proactive in treatment of lingering groundwater contamination. However, there has been a delay in implementing the remedies for OU006 and OU008.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the sites? If so, please give purpose and results.

   My office participates in quarterly LIR calls with the Army and EPA discussing the status of the above referenced sites.

   Additionally, I review QCSRs and reports for the groundwater monitoring at the OU003 and OU005 sites. I have also conducted site visits during sampling activities related to groundwater monitoring and additional investigations with those two sites, and have reviewed reports from those activities.

   There have not been any activities with the OU006 and OU008 sites since the ROD have been signed (other than the quarterly LIR calls).

3. Have there been any complaints, violations, or other incidents related to the sites requiring a response by your office? If so, please give details of the events and results of the responses.

No.

4. Do you feel well informed about the activities and progress related to the sites?
Yes.

5. What effects have site operations had on the surrounding community?
Not much.

6. Are you aware of any community concerns regarding the site or its operation and administration?
No

7. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?
No

5. Do you have any comments, suggestions, or recommendations regarding management or operation of the sites?
No.

INTERVIEW RECORD

Site Name: Fort Riley, KS	**EPA ID No.:KS6214020756**	
Subject: Five-Year Review for OU 001, OU 003, and OU 005	**Time:**	**Date:12/14/16**
Type: Telephone X Visit Email **Location of Visit:**	Incoming ○ Outgoing	

Contact Made By:

Name: Joan Cullen	**Title:** Technical Manager	**Organization:** USACE

Individual Contacted:

Name: Dr. Richard Shields	**Title: Program Manager**	**Organization: Fort Riley**

Telephone No: **Fax No:** **E-Mail Address:**	**Street Address: City, State, Zip:** Fort Riley, Kansas

Summary Of Conversation

Dr. Richard Shields is Program Manager for OUs at Fort Riley. Dr. Shields has been with Ft. Riley for 24 years, including 15 years as Program Manager. Dr. Shields said that his overall impression of the work conducted at the site is in good shape and that no conflicts with the community have occurred. He noted that there has not been much interest in the RAB, with only one member remaining.

Fort Riley tries to keep regulators informed and provide reports for review, and providing quarterly update reports.

Land use controls are in place and activities are monitored through the NEPA coordinator who provides plans, proposals, and subsurface work to the Environmental Department for review and approval.

OU 001 – Dr. Shields indicated that there were no concerns and that groundwater data indicated no exceedences of MCLs. The cover is burned and hayed annually to promote vegetation of native grasses.

OU 003 – There was some discussion about additional treatment at the site, but the area is heavily wooded and access for equipment would be difficult and a new road would have to be constructed each time the site was treated. MNA is occurring and it was decided not to enhance the treatment at this time.

OU 005 – The increase in the concentrations of COCs in 2014 was attributed to installation of a water line next to a monitoring well. A large volume of water used for drilling appeared to mobilize residual contamination. The three monitoring events seems to indicate that levels are attenuating and additional treatment might not be necessary.

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APPENDIX F

SOUTH FUNSTON LANDFILL

OU 001

BACKGROUND INFORMATION

- ANALYTICAL TABLES
- STATISTICAL ANALYSIS
- 2016 ANNUAL SITE INSPECTION

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Table 3.2
Field Monitoring Parameters
November 2013 Groundwater Sampling Event
Southwest Funston Landfill, Fort Riley, Kansas

Well ID	Date Sampled	Sampling Time	Amount Purged (Liters)	Flow Rate (mL/min)	Temperature (°C)	pH	Conductivity (mS/cm)	Turbidity (NTU)	Natural Attenuation Parameters			Water Level (feet btoc)
									ORP (mV)	DO (mg/L)	Fe^{+2} ppm	
SFL92-301	11/5/2013	1600	10	200	14.7	6.47	1.597	14.7	53.8	2.53	2.63	21.56
SFL92-401	11/7/2013	1002	9.8	280	14.92	7.02	1.158	2.06	92.0	0.40	0.92	20.18
SFL92-403	11/7/2013	0918	6.8	170	14.21	7.16	1.114	5.4	75.7	0.43	1.58	19.97
SFL92-601	11/6/2013	0902	4.8	160	13.71	6.87	2.623	3.04	44.5	0.42	1.66	22.7
SFL92-603	11/6/2013	1648	7	200	14.47	7.16	1.191	2.52	51.6	0.59	0.86	24.35
SFL94-02A	11/6/2013	1207	7.35	210	13.39	7.31	0.828	3.61	100.9	0.42	1.47	18.62
SFL94-03A	11/6/2013	1545	7	200	16.36	7.32	0.862	2.33	73.6	1.06	1.52	15.36
SFL94-04B	11/7/2013	1212	10.8	270	14.44	7.33	0.915	2.72	98.1	0.41	0.46	17.06
SFL97-903	11/5/2013	1348	7.2	180	13.88	6.55	0.782	2.72	41.2	0.57	2.77	21.38

Notes:
btoc = below top of casing
°C = degrees Celsius
DO = dissolved oxygen
Fe^{+2} = ferrous iron
ID = identification
mg/L = milligrams per liter
mL/Min = milliliters per minute
mS/cm = millisiemens per centimeter
mV = millivolts
NTU = nephelometric turbidity units
ORP = oxygen reduction potential
ppm = parts per million

Table 3.3
Summary of VOCs Detected
November 2013 Groundwater Sampling Event
Southwest Funston Landfill, Fort Riley, Kansas

VOC Compound	Units	MCL[1]	KDHE RSK[2]	Tap Water RSL[1]	SFL97-903	SFL92-301	SFL92-601	SFL92-601-FD	SFL94-02A	SFL94-03A	SFL92-603	SFL92-403	SFL92-401	SFL94-04B
					11/5/2013	11/5/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/7/2013	11/7/2013	11/7/2013
LTMCs and Associated LTMCs														
Benzene	µg/L	5	5	0.39	0.50 U	**0.59 J**	**1.9**	**2.0**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	µg/L	2	2	0.015	0.50 U	0.50 U	**0.48 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Non-LTMC VOCs														
1,1-Dichloroethane	µg/L	--	25.0	2.4	0.50 U	0.50 U	**0.29 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	µg/L	100	100	72	0.50 U	**5.7**	**0.61 J**	**0.65 J**	0.50 U	0.50 U	0.50 U	**0.84 J**	**1.3**	0.50 U
Isopropylbenzene	µg/L	--	451	390	0.50 U	0.50 U	**1.5**	**1.5**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Naphthalene	µg/L	--	1.11	0.14	2.0 U	2.0 U	**4.8**	**5.2**	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
o-Xylene	µg/L	--	--	190	0.50 U	0.50 U	**0.51 J**	**0.53 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Dichlorobenzene	µg/L	75	75	0.42	0.50 U	**4.7**	**2.2**	**2.5**	0.50 U	0.50 U	0.50 U	**0.59 J**	**0.94 J**	0.50 U
sec-Butylbenzene	µg/L	--	305	1,600	0.50 U	0.50 U	**0.23 J**	**0.26 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

[1] EPA Region 9 MCLs and RSLs November 2013 from site: http://www.epa.gov/region9/superfund/prg/

[2] Groundwater, Residential Scenario, Risk-Based Standards for Kansas RSK Manual – 5th Version, October 2010 with revised tables from March 2014.

Bold - Compound detected above the method detection limit (MDL).

Shading indicates values that have changed since the last report.

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

KDHE RSK = Kansas Department of Health and Environment Risk Based Standards for Kansas

MCL = maximum contaminant level

µg/L = micrograms per liter

RSL = regional screening level

U = Not detected. The associated value indicates the analyte limit of detection.

VOC = volatile organic compound

Table 3.4
Laboratory Analytical Summary
November 2013 Groundwater Sampling Event
Southwest Funston Landfill, Fort Riley, Kansas

			SFL97-903	SFL92-301	SFL92-601	SFL92-601-FD	SFL94-02A	SFL94-03A	SFL92-603	SFL92-403	SFL92-401	SFL94-04B
Compound	Units	MCL	11/5/2013	11/5/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/7/2013	11/7/2013	11/7/2013
1,1,1,2-Tetrachloroethane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	μg/L	200	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	μg/L	--	0.50 U	0.50 U	**0.29 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethylene	μg/L	7	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	μg/L	--	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U
1,2,3-Trichloropropane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	μg/L	70	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U
1,2,4-Trimethylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dibromo-3-chloropropane	μg/L	0.2	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	μg/L	0.05	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3,5-Trimethylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2,2-Dichloropropane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Chloroethyl vinyl ether	μg/L	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
2-Hexanone	μg/L	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-pentanone	μg/L	--	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Acetone	μg/L	--	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Acrolein	μg/L	--	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acrylonitrile	μg/L	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	μg/L	5	0.50 U	**0.59 J**	**1.9**	**2.0**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromobenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromochloromethane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	μg/L	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	μg/L	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	μg/L	100	0.50 U	**5.7**	**0.61 J**	**0.65 J**	0.50 U	0.50 U	0.50 U	**0.84 J**	**1.3**	0.50 U
Chloroethane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethylene	μg/L	70	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Table 3.4
Laboratory Analytical Summary
November 2013 Groundwater Sampling Event
Southwest Funston Landfill, Fort Riley, Kansas

Compound	Units	MCL	SFL97-903	SFL92-301	SFL92-601	SFL92-601-FD	SFL94-02A	SFL94-03A	SFL92-603	SFL92-403	SFL92-401	SFL94-04B
			11/5/2013	11/5/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/6/2013	11/7/2013	11/7/2013	11/7/2013
Dichlorodifluoromethane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	μg/L	700	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Hexachlorobutadiene	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	μg/L	--	0.50 U	0.50 U	**1.5**	**1.5**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m,p-Xylene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m-Dichlorobenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methyl bromide	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl ethyl ketone	μg/L	--	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Methyl Tert Butyl Ether	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methylene bromide	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methylene chloride	μg/L	5	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Naphthalene	μg/L	--	2.0 U	2.0 U	**4.8**	**5.2**	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
n-Butylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
n-Propylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Chlorotoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Dichlorobenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	μg/L	--	0.50 U	0.50 U	**0.51 J**	**0.53 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Chlorotoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Dichlorobenzene	μg/L	75	0.50 U	**4.7**	**2.2**	**2.5**	0.50 U	0.50 U	0.50 U	**0.59 J**	**0.94 J**	0.50 U
p-Isopropyltoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
sec-Butylbenzene	μg/L	--	0.50 U	0.50 U	**0.23 J**	**0.26 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Styrene	μg/L	100	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
tert-Butylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethylene	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Toluene	μg/L	1,000	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,2-Dichloroethylene	μg/L	100	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethylene	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichlorofluoromethane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl Acetate	μg/L	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl chloride	μg/L	2	0.50 U	0.50 U	**0.48 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

Bold - Compound detected above the MDL.

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

MCL = maximum contaminant level

MDL = method detection limit

μg/L = micrograms per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.4
Laboratory Analytical Summary
May 2016 Groundwater Sampling Event
Southwest Funston Landfill (FTRI-003), Fort Riley, Kansas

			SFL97-903	**SFL92-301**	**SFL92-601**	**SFL94-02A**	**SFL94-03A**	**SFL92-603**	**SFL92-603-FD**	**SFL92-403**	**SFL92-401**	**SFL94-04B**	**Trip Blank**	**Equipment Blank**
Compound	**Units**	**MCL**	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/4/2016	5/4/2016	5/3/2016	5/3/2016	5/4/2016
1,1,1,2-Tetrachloroethane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	µg/L	200	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	µg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	µg/L	--	0.50 U	0.50 U	**0.40 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethylene	µg/L	7	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	µg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,3-Trichloropropane	µg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	70	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trimethylbenzene	µg/L	--	0.50 U	0.50 U	1.0 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dibromo-3-chloropropane	µg/L	0.2	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromoethane	µg/L	0.05	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	µg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3,5-Trimethylbenzene	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2,2-Dichloropropane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Hexanone	µg/L	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-pentanone	µg/L	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Acetone	µg/L	--	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	µg/L	5	0.50 U	0.50 U	**2.3**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromobenzene	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromochloromethane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	µg/L	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	µg/L	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	µg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	µg/L	100	0.50 U	**3.3**	**0.38 J**	0.50 U	0.50 U	0.50 U	0.50 U	**0.55 J**	**1.0**	0.50 U	0.50 U	0.50 U
Chloroethane	µg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethylene	µg/L	70	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	µg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Table 3.4
Laboratory Analytical Summary
May 2016 Groundwater Sampling Event
Southwest Funston Landfill (FTRI-003), Fort Riley, Kansas

Compound	Units	MCL	SFL97-903	SFL92-301	SFL92-601	SFL94-02A	SFL94-03A	SFL92-603	SFL92-603-FD	SFL92-403	SFL92-401	SFL94-04B	Trip Blank	Equipment Blank
			5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/3/2016	5/4/2016	5/4/2016	5/3/2016	5/3/2016	5/4/2016
Dichlorodifluoromethane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	μg/L	700	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Isopropylbenzene	μg/L	--	0.50 U	0.50 U	**0.47 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m,p-Xylene	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
m-Dichlorobenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methyl bromide	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl chloride	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl ethyl ketone	μg/L	--	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	**3.3 J**
Methyl Tert Butyl Ether	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methylene bromide	μg/L	--	1.0 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methylene chloride	μg/L	5	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Naphthalene	μg/L	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
n-Butylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
n-Propylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Chlorotoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Dichlorobenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	μg/L	--	0.50 U	0.50 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Chlorotoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Dichlorobenzene	μg/L	75	0.50 U	**3.8**	**0.64 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Isopropyltoluene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
sec-Butylbenzene	μg/L	--	0.50 U	0.50 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Styrene	μg/L	100	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
tert-Butylbenzene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethylene	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Toluene	μg/L	1,000	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.57 J**	**0.38 J**
trans-1,2-Dichloroethylene	μg/L	100	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	μg/L	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethylene	μg/L	5	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichlorofluoromethane	μg/L	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	μg/L	2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

Bold - Compound detected above the MDL.

FD = field duplicate

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

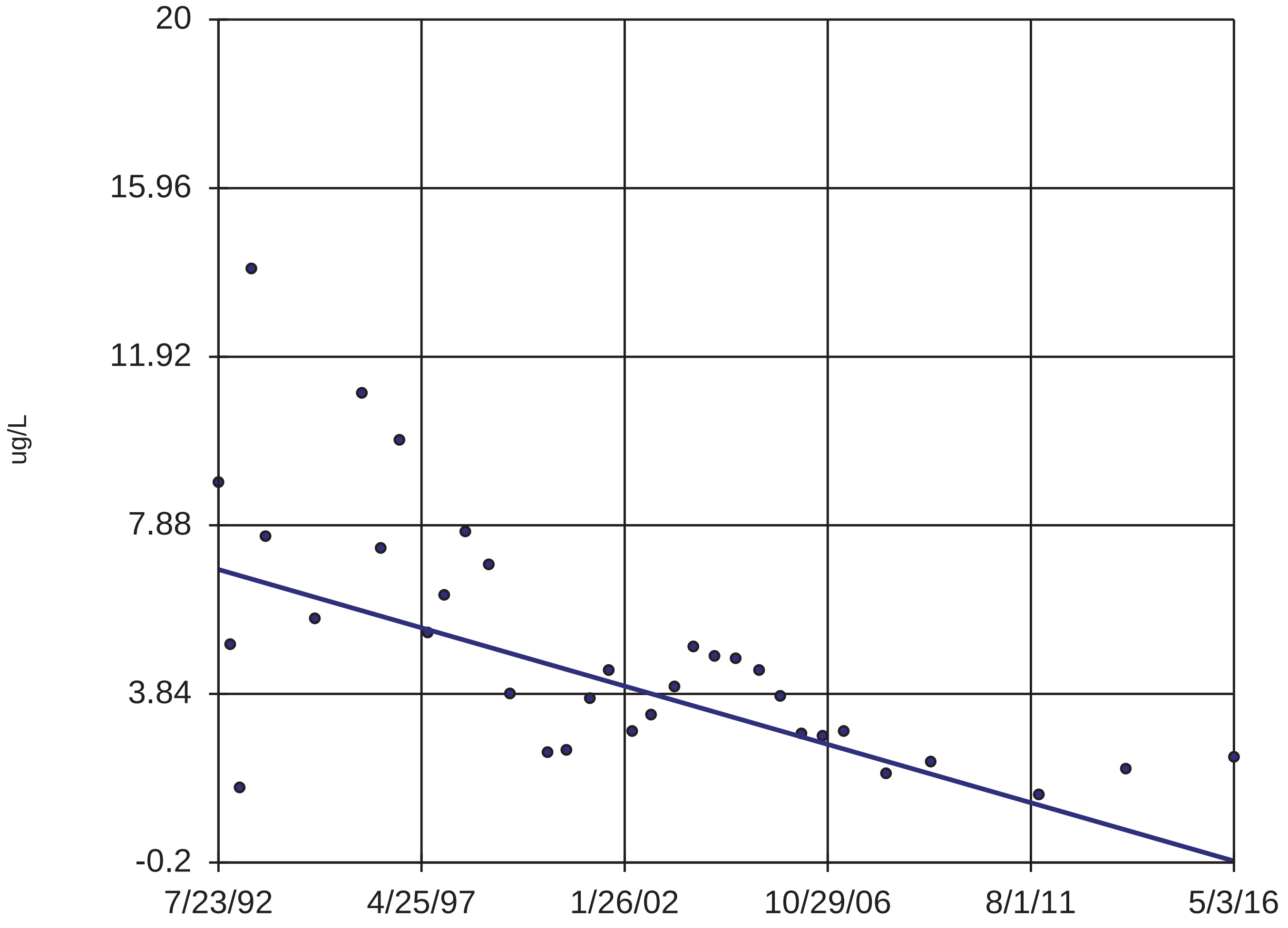
MDL = method detection limit

μg/L = micrograms per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Sen's Slope Estimator

SFL92601



n = 34

Slope = -0.2934
units per year.

Mann-Kendall
statistic = -303
critical = -158

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

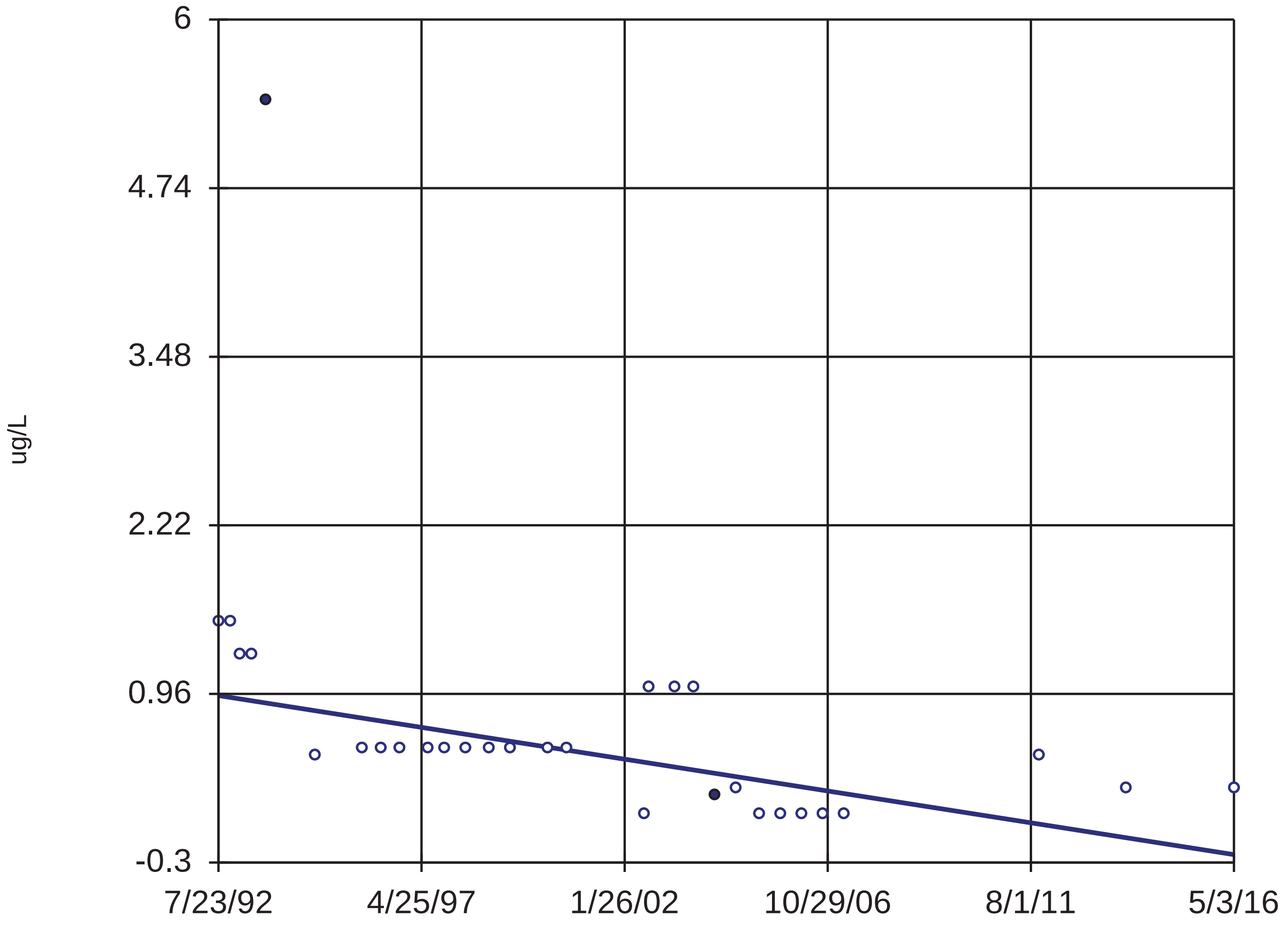
Constituent: Benzene   Analysis Run 7/29/2016 2:44 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

Sanitas™ v.9.5.25 Software licensed to HydroGeoLogic, Inc. EPA
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92301



n = 30

Slope = -0.04998
units per year.

Mann-Kendall
statistic = -216
critical = -132

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Tetrachloroethene   Analysis Run 7/29/2016 2:44 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

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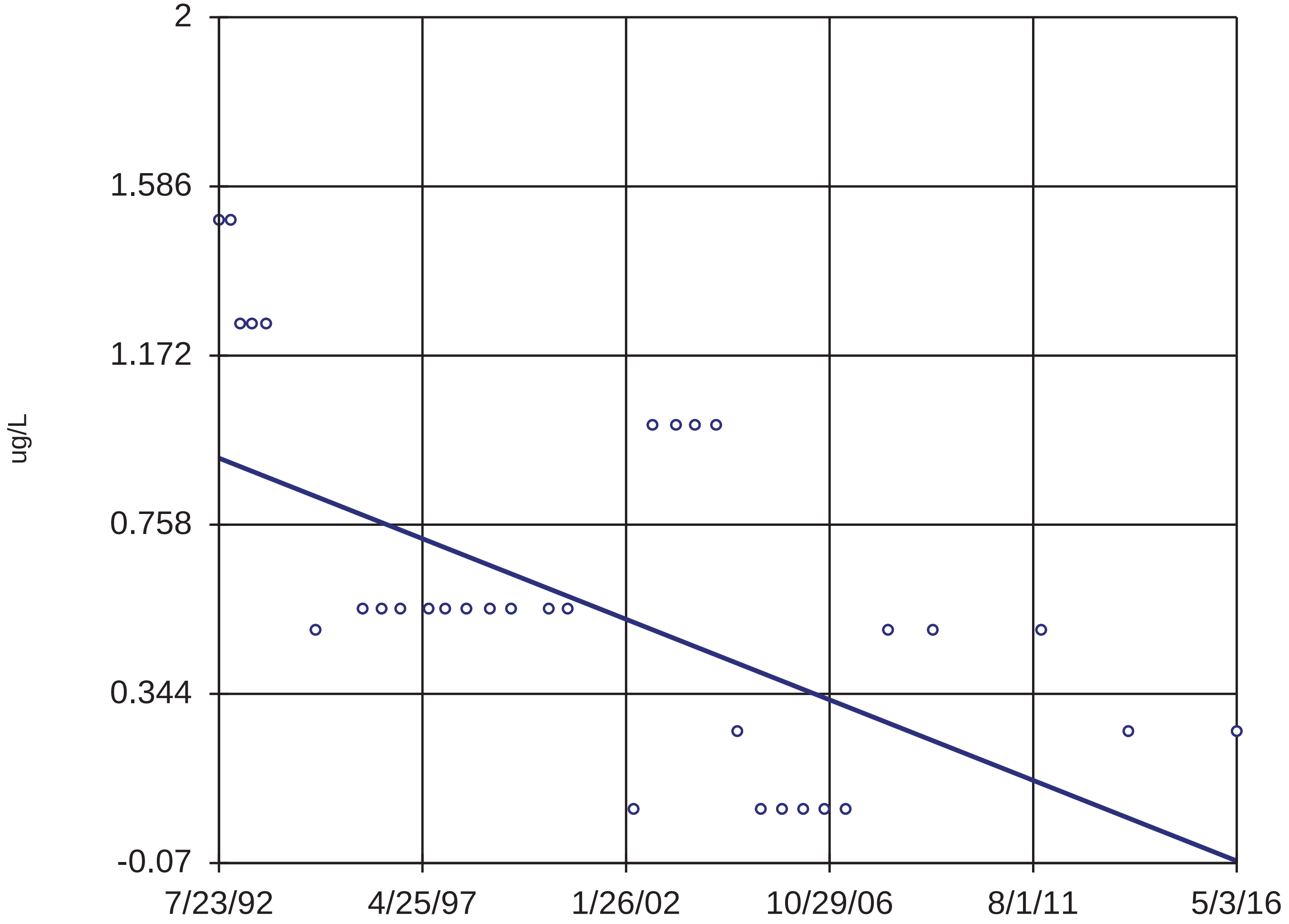
Sen's Slope Estimator

SFL92601



n = 32

Slope = -0.04142
units per year.

Mann-Kendall
statistic = -233
critical = -145

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Tetrachloroethene Analysis Run 7/29/2016 2:44 PM

FTRI-003 Client: HydroGeoLogic Data: Flat File - data for statistical analysis_mm

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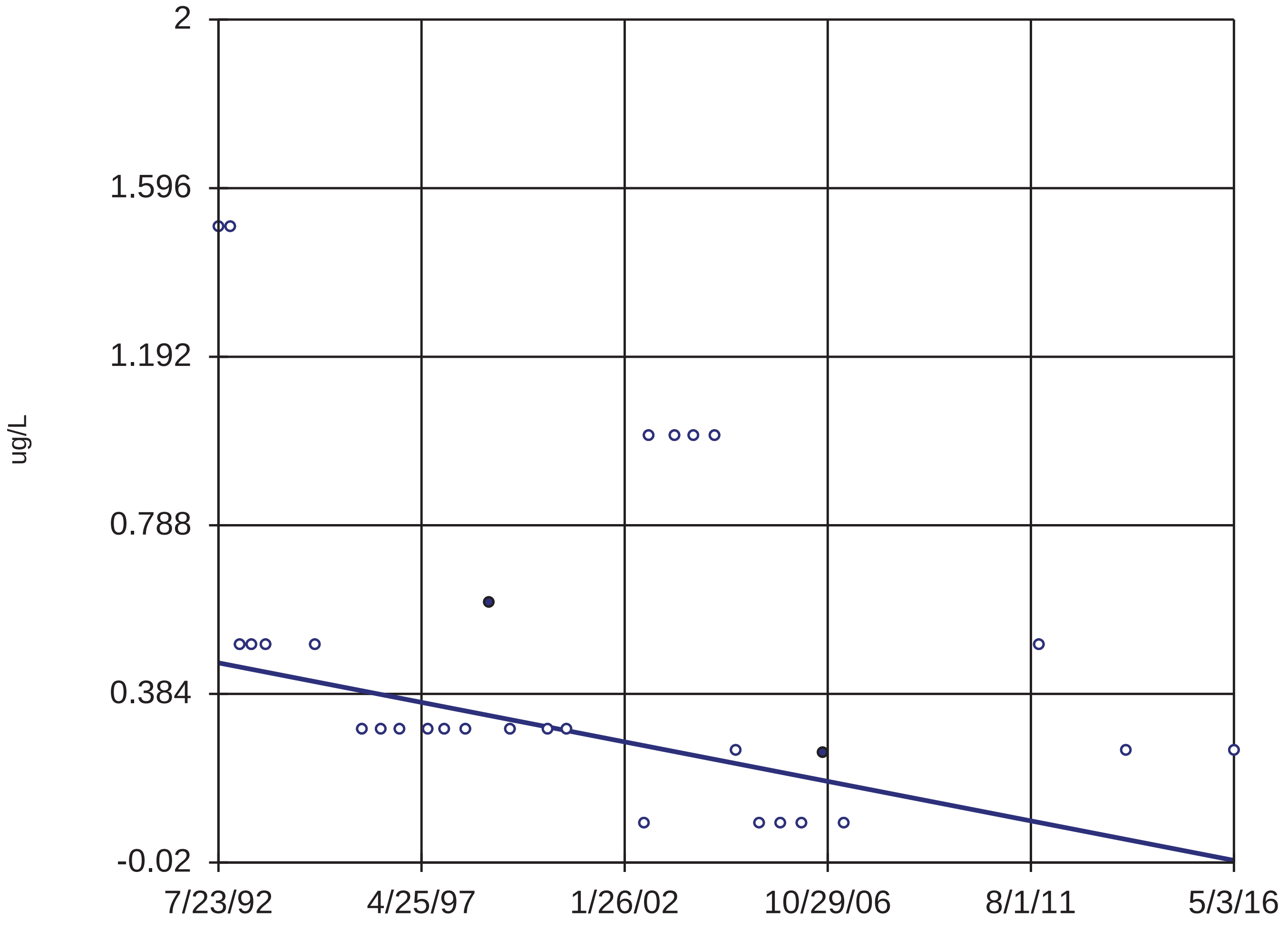
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92301



n = 30

Slope = -0.01989
units per year.

Mann-Kendall
statistic = -163
critical = -132

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Trichloroethene Analysis Run 7/29/2016 2:44 PM

FTRI-003 Client: HydroGeoLogic Data: Flat File - data for statistical analysis_mm

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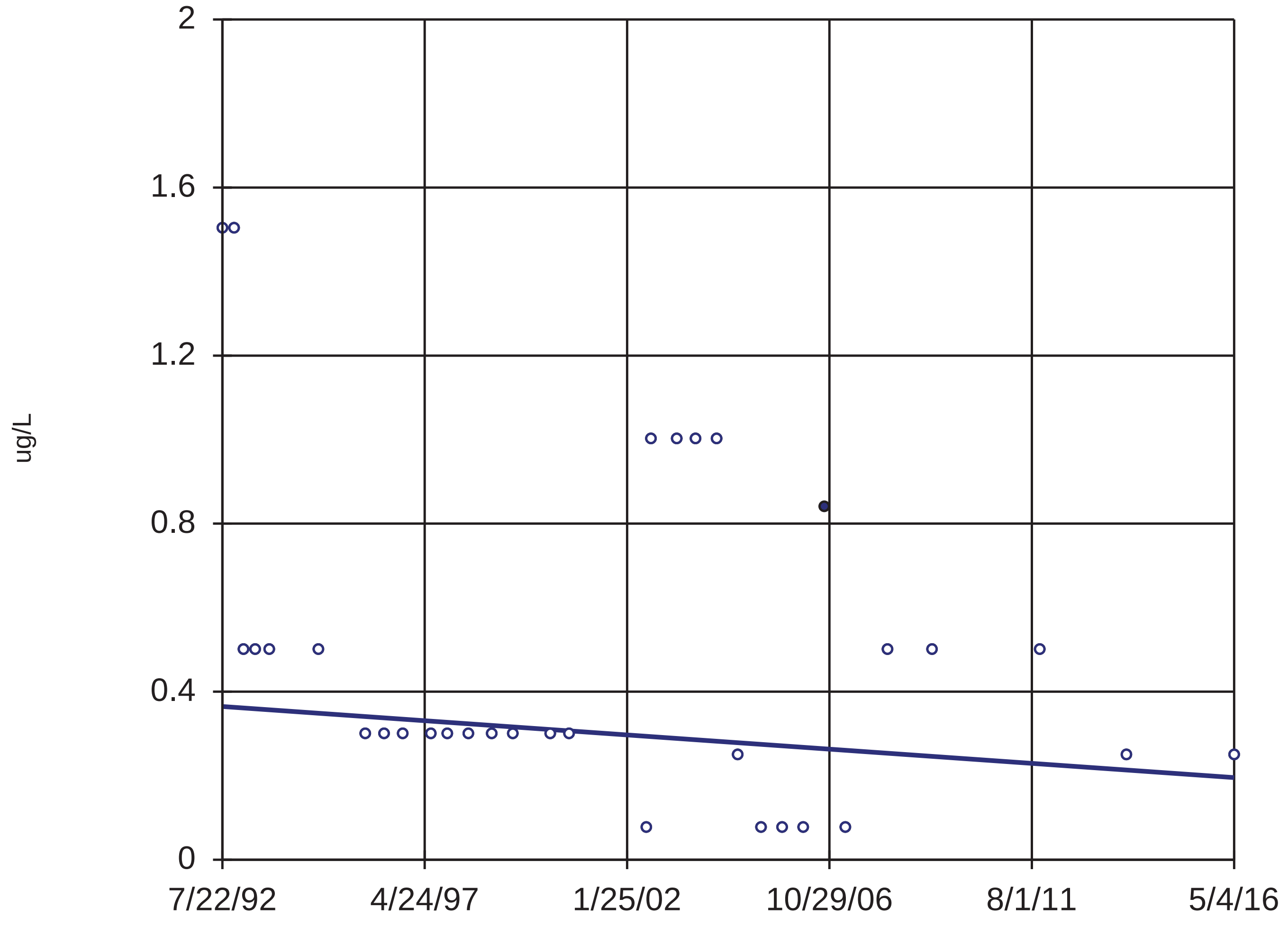
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92401



n = 32

Slope = -0.007104
units per year.

Mann-Kendall
statistic = -134
critical = -145

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Trichloroethene   Analysis Run 7/29/2016 2:45 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

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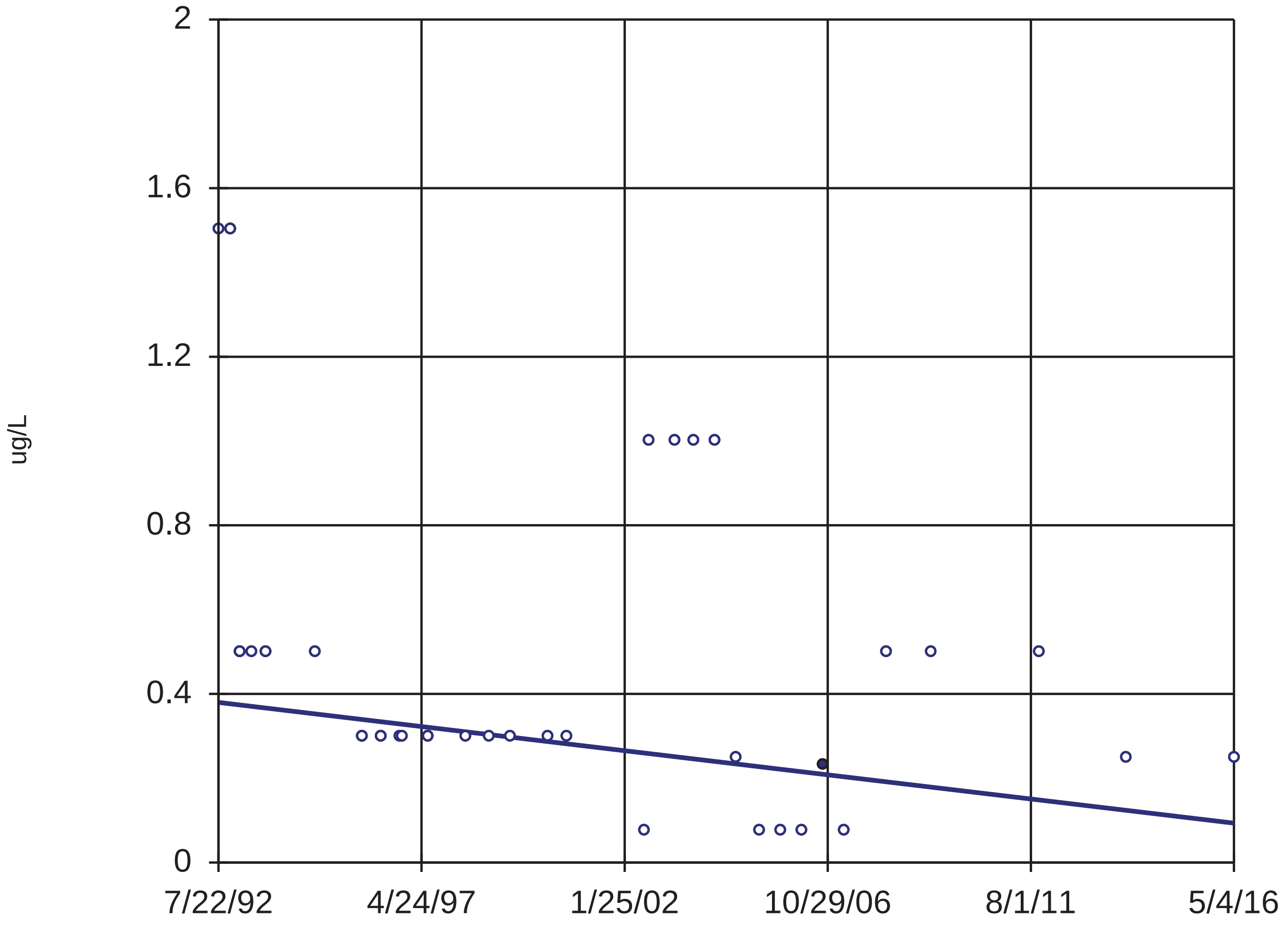
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92403



n = 38

Slope = -0.01203
units per year.

Mann-Kendall
statistic = -253
critical = -186

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Trichloroethene   Analysis Run 7/29/2016 2:45 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

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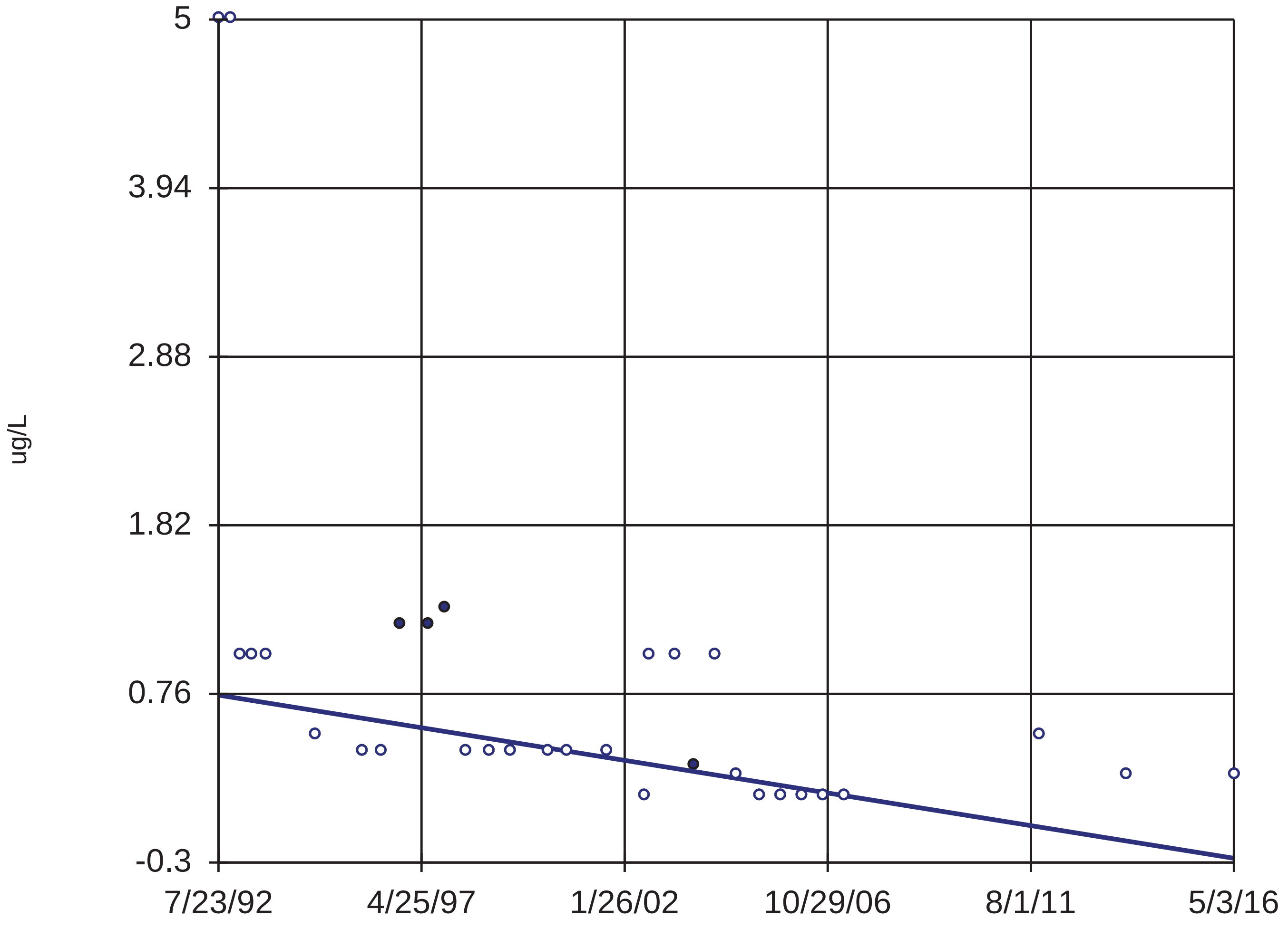
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92301



n = 31

Slope = -0.04313
units per year.

Mann-Kendall
statistic = -239
critical = -138

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

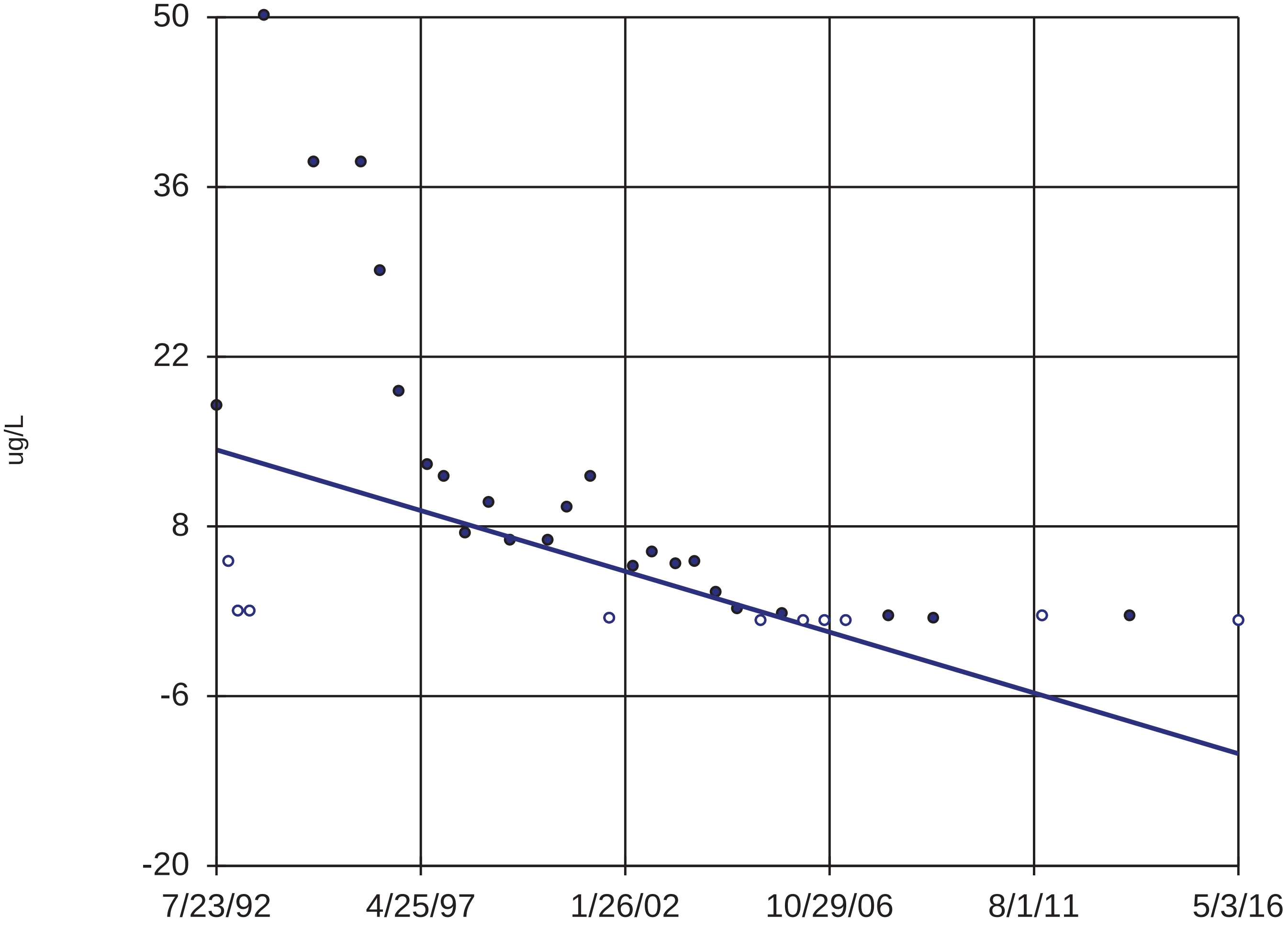
Constituent: Vinyl chloride   Analysis Run 7/29/2016 2:45 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

Sanitas™ v.9.5.25 Software licensed to HydroGeoLogic, Inc. EPA
Hollow symbols indicate censored values.

Sen's Slope Estimator

SFL92601



n = 34

Slope = -1.053
units per year.

Mann-Kendall
statistic = -342
critical = -158

Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Vinyl chloride   Analysis Run 7/29/2016 2:45 PM

FTRI-003   Client: HydroGeoLogic   Data: Flat File - data for statistical analysis_mm

FINAL
2016 LONG-TERM MONITORING REPORT
SOUTHWEST FUNSTON LANDFILL (FTRI-003)
FORT RILEY, KANSAS

REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

Prepared for:

U.S. Army Corps of Engineers
Kansas City District

Contract W912DQ-13-D-3000
Task Order 0004

Prepared by:

HydroGeoLogic, Inc.
6340 Glenwood, Suite 200
Building #7
Overland Park, KS 66202

October 2016

FINAL
2016 LONG-TERM MONITORING REPORT
SOUTHWEST FUNSTON LANDFILL (FTRI-003)
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U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, MO 64106

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October 2016

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LIST OF ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
ASTM	ASTM International
CFA	Camp Funston Area
CTI	CTI & Associates, Inc.
DCE	dichloroethene
DCP	data collection platform
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
ft	feet or foot
ft/mi	feet per mile
HGL	HydroGeoLogic, Inc.
KRHDB	Kansas River Henry Drive Bridge
KDHE	Kansas Department of Health and Environment
LTM	long-term monitoring
LTMC	Long-Term Monitoring Constituent
LTO	long-term operation
MCL	maximum contaminant level
μg/L	micrograms per liter
MTBE	tert-butyl ether
PCE	tetrachloroethene
PDB	1,4-dichlorobenzene
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
ROD	Record of Decision
RSKs	risk-based standards for Kansas
RSL	regional screening level
SDT	Significantly Decreasing Trend
SFL	Southwest Funston Landfill
SIT	Significantly Increasing Trend
SSI	Statistically Significant Increase
SSD	Statistically Significant Decrease

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SWL	static water level
TCE	trichloroethene
TMCM	Three Mile Creek Middle
TMCD	Three Mile Creek Downstream
TO	task order
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VOC	volatile organic compound

FINAL
2016 LONG-TERM MONITORING REPORT
SOUTHWEST FUNSTON LANDFILL (FTRI-003)
FORT RILEY, KANSAS
REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) is conducting long-term monitoring (LTM) at Southwest Funston Landfill, Fort Riley, Kansas (FTRI-003) (Figure 1.1). This work is being conducted under U.S. Army Corps of Engineers, Northwestern Division, Kansas City District (USACE) contract W912DQ-13-D-3000, task order (TO) 0004, Regional long-term operation (LTO)/LTM. LTM sampling and reporting is being completed as required under the following post-closure documents:

- *Long-Term Groundwater Monitoring Plan for Southwest Funston Landfill, Operable Unit Number 001* (USACE, 1997);
- *Draft Final Remedial Action Completion Report, Southwest Funston Landfill Site, OU001* (Fort Riley, 2009); and
- *Draft Final Long-Term Management and Care Plan, Southwest Funston Landfill Site, OU001* (Fort Riley, 2011).

1.1 PURPOSE AND SCOPE

This LTM report presents the results of the groundwater sampling and landfill inspection conducted by HGL at FTRI-003 in May 2016. Groundwater sampling and associated activities were conducted May 2 through May 5, 2016, and the landfill inspection was conducted on May 16, 2016. The location of FTRI-003 is shown on Figure 1.1 and the location of the LTM wells is shown on Figure 1.2. HGL conducted the following field activities:

- Gauged 13 LTM wells;
- Purged and sampled 9 LTM wells;
- Inspected the landfill surface, vegetative cover, signage, and monitoring wells; documented activities and observations on Record of Inspection forms and with photographs.

Groundwater sampling activities were conducted in accordance with the *Site-Specific Work Plan* (HGL, 2014a). As required by the *Long-Term Groundwater Monitoring Plan* (USACE, 1997), a statistical analysis was conducted, including historical results and 2016 data, to determine contaminant trends for Long-Term Monitoring Constituents (LTMCs) (benzene and vinyl chloride) and associated LTMCs (cis- and trans-1,2-dichloroethene [cis-1,2-DCE and trans-1,2-DCE), tetrachloroethene [PCE], and trichloroethene [TCE]).

Before 2007, sampling at FTRI-003 was conducted on a semiannual basis. Since 2007, sampling at FTRI-003 has been conducted in 2007, 2008, 2009, 2011, 2013, and 2016.

The Quality Control Summary Report (QCSR) for the May 2016 groundwater sampling event was submitted under separate cover (HGL, 2016). The QCSR discusses laboratory and field quality control (QC), including field completeness, sampling technique, sampling precision, trip blank results, and any deviations from planned activities. The QCSR includes the validated laboratory data sheets.

1.2 WELLS SAMPLED AND PARAMETERS ANALYZED

Water levels were measured in 13 of the LTM wells and groundwater samples were collected from 9 of the LTM wells. All planned samples were collected. LTM wells sampled along with field and laboratory analyses conducted are summarized in Table 1.1. Figure 1.2 shows the location of the LTM wells where water level measurements were collected and where groundwater samples were collected.

Sampled LTM wells were analyzed for volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (EPA) Method SW846 8260B. A trip blank was collected and shipped with each sample cooler. A field duplicate pair was collected from well SFL92-603 and a matrix spike/matrix spike duplicate (MS/MSD) was collected from well SFL97-903. The QC samples were analyzed as planned. Samples were shipped to Accutest Laboratories, Inc. in Orlando, Florida. The results of the laboratory analyses are discussed in Section 3.2.

2.0 HYDROGEOLOGIC CONDITIONS

This section presents a summary of the historical surface water hydrology and hydrogeology. The U.S. Geological Survey (USGS) collected continuous monitoring data for wells SFL92-301 and SFL94-06A and stream gauging stations located along Three Mile Creek until 2011. Appendix B includes the last table (Table 2-1) and figure (Figure 2-1) generated with data from the USGS.

2.1 SURFACE WATER HYDROLOGY

Fort Riley is located along the north side of the Kansas River and is bordered by other bodies of water associated with the Kansas River system. This includes Milford Lake (a reservoir on the Republican River) 2 miles to the west of Fort Riley; the Republican River (downstream of Milford Lake) to the southwest, bordering Fort Riley; and the Smoky Hill River approaching the border of Fort Riley from the south. The confluence of the two rivers is approximately 2.5 miles southwest and upstream of the FTRI-003 and Camp Funston Area (CFA). Numerous intermittent and perennial creeks and streams are located at Fort Riley and discharge into the Kansas River system. The FTRI-003 and CFA lie within the alluvial valley of the Kansas River (see Figure 1.1).

Three Mile Creek is located between FTRI-003 and CFA. Three USGS stream gauging stations were located along Three Mile Creek in the vicinity of FTRI-003: Three Mile Creek Upstream, Three Mile Creek Middle (TMCM), and Three Mile Creek Downstream (TMCD). Based on the 1998 Annual Monitoring Report for the FTRI-003 (USGS, 1999), the stage at the TMCD gauging station is not affected by the stage of the Kansas River when the river at the Kansas River Henry Drive Bridge (KRHDB) gauging station is less than approximately 1,038 feet (ft) above mean sea level (amsl). The stage at the TMCM gauging station begins to show backwater effects when the Kansas River at the KRHDB gauging station is greater than approximately 1,046 ft amsl (USGS, 1999). The KRHBD location is approximately 2.5 miles west of the site at the Henry Drive Bridge over the Kansas River (see Figure 1.1).

2.2 HYDROGEOLOGY

Generally, three hydrogeologic environments are present beneath Fort Riley. The Kansas River alluvial sediments consist of alternating layers of sand, gravel, silt, and clay. The upland terrace areas consist of thin, unconsolidated sediments overlying bedrock. The transition zones along the river valley margins consist of colluvial deposits derived from the upland terraces overlying and intermingled with alluvial sediments of the river valley. These unconsolidated materials are underlain by alternating beds of limestone and shale. The FTRI-003 and CFA are both located on Kansas River alluvium.

An extensive analysis of the groundwater hydrogeology and the effects of the Kansas River and Three Mile Creek on groundwater flow in the vicinity of the FTRI-003 and the CFA were included in the 1996 Annual Monitoring Report for FTRI-003 (Meyers and Trombley, 1997). In addition, the USGS completed an investigation to characterize and model the groundwater flow in the Kansas River Valley, including the FTRI-003 and CFA. Conclusions from the USGS modeling effort are summarized in the report titled *Characterization and Simulation of Ground-Water Flow in the Kansas River at Fort Riley, Kansas 1990-98* (USGS, 2000).

The USGS analyzed the effects of the stage changes in the Kansas River and in Three Mile Creek prior to 1995 on the groundwater flow in the vicinity of the FTRI-003 and CFA and determined that the Kansas River affects regional groundwater flow and that Three Mile Creek affects local groundwater flow. The direction of shallow groundwater movement at the FTRI-003 and the CFA is primarily dependent upon regional and local precipitation, and upon stage fluctuations of the Kansas River system, including occasional releases from upstream reservoirs (USGS, 1999). The analyses indicated that when the Kansas River stage is high or rising, the groundwater flow direction at FTRI-003 is northeast away from the Kansas River. When the Kansas River stage is low or falling, the groundwater flow direction at FTRI-003 and CFA is south to southeast toward the Kansas River (USGS, 2000).

3.0 SUMMARY OF RESULTS

This section summarizes the monitoring well and landfill cover inspections, fieldwork conducted, analytical results of groundwater samples and comparison to risk-based levels, and the statistical analyses and results.

3.1 INSPECTIONS

The following items of note were observed during the monitoring well inspections conducted during the groundwater sampling event on May 2, 2016:

- All 13 LTM wells require painting.
- SFL92-301.Missing J-plug.
- SFL94-05A. Missing lock.
- SFL92-201. The lid is broken and tree roots are inside the protective casing.
- SFL94-02A, SFL94-03A, SFL94-04B, SFL94-05A, SFL94-06A, and SFL92-201. Vegetation needs to be cleared.

The FTRI-003 landfill was inspected on May 16, 2016. The inspection team consisted of two field personnel from HGL; two representatives of the FTRI Directorate of Public Works, Environmental Division; a representative of the Kansas Department of Health and Environment (KDHE); a representative of EPA; and two representatives of USACE. The landfill surface, vegetative cover, signage, and monitoring wells were inspected and conditions were documented with photographs and on the Record of Inspection forms. A figure showing the inspection route and features/items noted during the cover inspection, along with inspection photographs and forms are included in Appendix C.

The landfill cover was observed to be in good condition. A few items of note from the May 2016 inspection are summarized below:

- No standing water was observed on the landfill, despite significant rainfall prior to the inspection.
- Metal debris was visible on the surface of a small area on the east-central part of the landfill (Photo #7 in Appendix C).
- The vegetative cover was sparse in several small areas on the east side of the landfill (Photo #3 and 6 in Appendix C).

Because the landfill had been burned just before the May inspection, HGL returned to the landfill on July 14, 2016, to observe whether the areas of sparse vegetation observed in May had recovered after the burn and shown signs of growth. Upon inspection it was noted that the landfill had been mowed for hay which was left in place to dry. A photo log of the July 2016 site visit is presented in Appendix C. Vegetation was observed on all former trenches, though minimal vegetation was observed on a few of the former trench locations. The main areas of sparse vegetation were observed on the former ponding area located on the east side of the landfill (Photos #8, #9, and #10), a former trench area located on the south-central side of the landfill (Photo #12), and the northwestern former trench on the landfill (Photos #17 and #18). All other trenches had a moderate to significant amount of vegetation.

The FTRI agronomist, Jerold Spohn, reported the following, with regard to the vegetative cover on July 5, 2016 (email correspondence):

- Late-successional vegetation with a good forb component starting to establish.
- Landfill was treated for noxious weeds in 2015 and will continue to be monitored.
- Landfill does not need to be overseeded at this time.

After reviewing the July 14, 2016, daily report submitted by HGL for the follow-on inspection, Mr. Spohn requested (email correspondence July 21, 2016) that HGL "overseed any areas that have less than 1 plant per square foot with the current Conservation Reserve Program (CRP) mix for Riley County at the appropriate time this fall."

3.2 LTM SAMPLING AND MONITORING WELL MAINTENANCE

Static water levels (SWLs) were measured in specified wells on May 2, 2016, before groundwater samples were collected on May 3, 2106. Field parameters were measured and recorded during groundwater sampling activities. Field Forms are included in Appendix A.

3.2.1 Static Water Levels

Table 3.1 presents SWL data collected from the 13 LTM wells on May 2, 2016. Figure 3.1 presents the FTRI-003 potentiometric surface generated from the SWL measurements. The general groundwater flow direction across FTRI-003 was south, toward the Kansas River, and the hydraulic gradient was 0.00022 (1.18 feet per mile [ft/mi]). The groundwater flow gradient across the FTRI-003 was measured between SFL92-101 and SFL92-301 (Figure 3.1).

3.2.2 Groundwater Sampling

Samples were collected from 7 of the 9 wells specified in Table 1.1 using the dedicated bladder pumps and polyethylene tubing installed in the monitoring wells. Samples were collected from the remaining 2 wells using a non-dedicated bladder pump. Wells were sampled using low-flow purging techniques, which included the collection of field parameters (pH, specific conductivity, temperature, turbidity, oxidation reduction potential [ORP], dissolved oxygen [DO], and ferrous iron). Water levels were initially recorded then measured approximately every 3 to 5 minutes to monitor drawdown during purging. Field parameters were also measured approximately every 3 to 5 minutes to ensure the groundwater parameters had stabilized before samples were collected. After purging was complete, groundwater samples were collected for VOC analysis using EPA analytical method 8260B. Field sheets for the May 2016 groundwater sampling event are presented in Appendix A.

Well purging was performed in accordance with the *Site-Specific Work Plan* (HGL, 2014a). Table 3.2 presents the field parameters for the 2016 groundwater sampling event. The field stabilization criteria requirements were met for the sampled wells. These data were recorded on the field sampling forms, which are included in Appendix A.

3.2.3 Monitoring Well Maintenance

While measuring SWLs, it was noted that the polyvinyl chloride (PVC) stickup casing on well SFL92-601 had come loose since the last sampling event in 2013, and that one of the well bollards had been struck and was leaning over. The joint where the casing had come loose was located within the steel casing approximately two feet below the top of the PVC casing. HGL repaired the PVC casing using an epoxy putty. The leaning bollard was repaired by manually pulling the bollard upright, then adding and compacting dirt fill to stabilize the base of the bollard. Photographs of the well and bollard repair are included in Appendix A.

3.3 ANALYTICAL RESULTS

Groundwater samples were collected from 9 of the 13 LTM wells as specified in the *Site-Specific Work Plan*. Results of the laboratory analyses and historical trends in the data are discussed below. Historical data are presented in Appendix B. Table 3.3 summarizes the 2016 detections, and all results for 2016 are presented in Table 3.4. Figure 3.2 presents the locations and concentrations of LTMC analytes detected in FTRI-003 shallow monitoring wells during 2016.

No LTMCs or associated LTMC VOCs were detected in any of the LTM wells, except SFL92-601. Benzene was detected at SFL92-601 at a concentration of 2.3 micrograms per liter (μg/L). Table 3.3 presents the analytes detected in the nine groundwater monitoring wells sampled during the May 2016 groundwater sampling event, and the EPA maximum contaminant levels (MCLs) (EPA, 2016), the Kansas Department of Health and Environment (KDHE) Risk-Based Standards for Kansas (RSKs) for residential groundwater (KDHE, 2010), and the EPA Regional Screening Levels (RSLs) for tap water (EPA, 2016).

These screening levels are not intended to be action levels for the FTRI-003 and are used in this monitoring program only as a tool for evaluating analytical results. RSLs are often established at concentrations below what current analytical laboratory methodology can achieve. As a result, RSLs have been excluded from a number of interim reports and are not discussed in the textual summaries of site concentrations in this report. The RSLs were retained in Table 3.3 because EPA recommends that they be used as a reference point for site "screening." Though chemical concentrations above the RSL would not automatically designate a site as contaminated or trigger a response action, exceeding an RSL suggests that further evaluation may be appropriate. RSLs are therefore used as a frame of reference for analytical results that are less than the MCLs and RSKs.

Historical data (1992 to 2009, 2011 and 2013) for VOCs are presented on Tables B.1 in Appendix B. Appendix B Table B.2 lists historical data for metals and Appendix B Table B.3 lists historical data for the water quality parameters. There were no new data for these tables in 2016. In Appendix B tables, where analytes were detected in field duplicate pairs, the higher of the two values was entered. Results for m&p-xylenes and o-xylene were added together and are listed in Table B.1 as "total xylenes" to be consistent with previous entries. The laboratory began reporting results for methyl tert-butyl ether (MTBE) in September 2003; therefore, MTBE was included in Appendix B, Table B.1 starting with the 2004 Long-Term Monitoring Report (ECC, 2004). Historically, MTBE has been detected in monitoring well SFL92-601.

3.3.1 Benzene

Benzene, an LTMC, was detected in well SFL92-601 at 2.3 μg/L in May 2016, which is below the MCL and RSK of 5.0 μg/L.

Before June 1999, benzene was detected at well SFL92-601 at concentrations greater than the MCL with reasonable consistency. The highest benzene concentration of 14 μg/L was detected in 1993. In addition, before 1999 benzene was detected at levels below the MCL at least one time in wells SFL92-601, SFL92-603, SFL92-801, SFL94-01A, SFL94-03B, and SFL94-04B. Since 1999 benzene has been detected consistently below the MCL at well SFL92-601, has been detected once in SFL92-403 at 0.67 in 2005 and has been detected during the previous two sampling events at SF92-301 at 0.14 μg/L (2011) and 0.59 J μg/L (2013).

3.3.2 cis-1,2-DCE and trans-1,2-DCE

Trans-1,2-DCE is identified as an associated LTMC at this site and was not detected in monitoring wells sampled during the May 2016 groundwater sampling event. Thus, from 2002 through 2016, trans-l,2-DCE has not been detected at any wells.

Cis-1,2-DCE is identified as an associated LTMC and was not detected in monitoring wells sampled during the May 2016 groundwater sampling event or any wells sampled after 2009. The highest concentration of cis-l,2-DCE historically detected at the FTRI-003 was reported at SFL92-601 during October 1994 (3.4 μg/L). From 2002 to 2009, detected concentrations of cis-1,2-DCE were consistently low, rarely exceeding 1 μg/L. The MCL for cis-1,2-DCE is 70 μg/L.

3.3.3 PCE

PCE, an associated LTMC, was not detected in any wells sampled during the May 2016 groundwater sampling event. The only historical detections for PCE were in well SFL92-301 in September 1993 (5.4 μg/L) and March 2003 (0.2 J μg/L).

3.3.4 TCE

TCE, an associated LTMC, was not detected in any wells sampled during the May 2016 groundwater sampling event. Historical detections of TCE were reported in well SFL92-701 at 4.3 μg/L in May 1993, and in well SFL92-301 at 0.6 μg/L in December 1998. TCE was not detected from 1999 through March 2006. TCE was detected in the following wells during the September 2006 sampling event: SFL92-301 (0.24J μg/L), SFL92-401 (0.84J μg/L), SFL92-403 (0.23 μg/L), SFL92-601 (1.24J μg/L), SFL92-603 (0.30 J μg/L), and SFL94-03A (0.35J μg/L). No TCE detections have been observed since September 2006. The MCL for TCE is 5.0 μg/L.

3.3.5 Vinyl Chloride

Vinyl chloride, an LTMC, was not detected in any wells sampled during the May 2016 groundwater sampling event.

Historical data indicates that vinyl chloride has been detected in 15 of the site monitoring wells with the majority of detections occurring in the 1995 to 1999-time period. The maximum concentration observed at the site was in SFL92-601 in 1993 at 50 µg/L. Between 1999 and 2009 vinyl chloride had been detected relatively consistently in wells SFL92-401, SFL92-403, SFL92-601 and SFL92-603 with peak values occurring around the year 2000. The last detection of vinyl chloride above the MCL of 2 µg/L was in 2007 at well SFL92-601.

3.3.6 Non-LTMC VOCs

In 2016, the following non-LTMC VOCs were detected at concentrations less than their respective MCLs and KDHE RSKs:

- 1,4-dichlorobenzene (PDB)
- 1,1-dichloroethane
- chlorobenzene
- isopropylbenzene

Historical detections for non-LTMC VOCs are consistently at low concentrations. The results for the non-LTMC VOCs detected in 2016 and their associated screening levels are listed in Table 3.3.

3.4 STATISTICAL ANALYSIS

The statistical evaluation of the 2016 groundwater data was conducted in accordance with the criteria and procedures detailed in the 1997 Long-Term Groundwater Monitoring Plan, EPA guidance (EPA, 2009), and ASTM International guidance (ASTM, 1998). Statistical analyses were performed on the LTMCs benzene and vinyl chloride (at wells where data was available). Vinyl chloride is a degradation product of 1,2-DCE (total), PCE, and TCE; therefore, these compounds were included in this report as associated LTMCs and also underwent statistical analysis. The individual constituents that were evaluated are listed in Table 3.5. The results of the statistical analyses are summarized below and the details of each analysis presented in Appendix D. Conclusions are presented in Table 3.6. Plots of the statistical analyses for VOCs are included in Appendix D.

3.4.1 Approach

The Sanitas™ program (Sanitas Technologies) was used for the statistical evaluation of analytical results. Nondetect values are handled in accordance with the EPA Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, (EPA, 2009). During statistical analysis, Sanitas™ handles nondetect results differently depending on the rate of nondetects in order to perform the statistical analysis. The different procedures for handling nondetects are detailed below:

- If less than 15 percent of the background observations are nondetects, these will be replaced with one-half of the method detection limit before running the analysis;

- If more than 15 percent but less than 50 percent of the background data are less than the detection limit, the sample mean and sample standard deviation of the dataset are adjusted according to the method of Cohen, Aitchison, or Kaplan-Meier;
- If more than 50 percent of the background data are less than the detection limit, a nonparametric prediction interval will be computed; and
- If more than 90 percent of the background data are less than the detection limit, Sanitas™ provides an option to construct a Poisson-based prediction interval.

Methods used to evaluate groundwater data are discussed below.

Intrawell comparison tests, where concentration level comparisons are made within the same well, were performed for each of the constituents in Table 3.5. In cases where there were at least eight independent samples for a well, at least 50 percent of the samples from a well had detections, and the null hypothesis for Shapiro-Wilk test of normality was not rejected, two-tailed parametric prediction interval charts were constructed. If all of these criteria were not met, nonparametric prediction interval charts were constructed. Intrawell comparison tests were not performed for constituents with no detections in the given well.

For analytes detected during 2016, statistical evaluations were performed (where sufficient data were available) to identify potential trends, and suspect data points. Statistically significant increases (SSIs) or statistically significant decreases (SSDs) were determined using a prediction limit test, which indicates increasing or decreasing constituent concentrations depending on the prediction limit. The prediction limit is established based on historical data. All available data prior to 2016 were used to establish background values for the prediction limit test. EPA Outlier tests are conducted to determine a statistical outlier, which is a value with an extreme variance from the other values in the dataset. Sen's Slope/Mann Kendall trend tests are conducted to identify Significantly Increasing Trends (SITs) or Significantly Decreasing Trends (SDTs) to further assist in the statistical evaluation. The Mann Kendall outputs are also overlaid with time series plots and a linear “best fit” line. While these time series plots can be useful for making generalizations regarding the conditions at the wells under investigation, the appearance of a trend by linear correlation does not necessarily indicate an actual increasing or decreasing trend over time. A linear “best fit” line is not always an indicator of a statistically significant trend.

Outlier and trend testing were performed in accordance with EPA and ASTM criteria and methods.

3.4.2 Results of Statistical Analysis

The VOCs listed in Table 3.5 were statistically evaluated for the following monitoring wells (the set of wells where samples were collected for analysis of VOCs in 2016):

SFL92-301
SFL92-401
SFL92-403
SFL92-601
SFL92-603
SFL94-02A
SFL94-03A
SFL94-04B
SFL97-903

Table 3.6 is a summary of the results of the statistical evaluations performed in 2016.

3.4.3 Benzene

Benzene is an LTMC. Intrawell tests were performed on the benzene results and found to be within predicted limits. An SDT was identified in well SFL92-601. No SSIs, SSDs, or statistical outliers were identified for benzene in any of the wells sampled.

3.4.4 cis-1,2-DCE and trans-1,2-DCE

Both cis-1,2-DCE and trans-1,2-DCE are associated LTMCs. No SSIs, SSDs, or statistical outliers were identified for trans-1,2-DCE in any of the wells sampled. SDTs, for trans-1,2-DCE, were identified in wells SFL92-301, SFL92-401, SFL92-403, SFL92-601, and SFL92-603. However, because the reporting limits for VOCs are low, occasional detections followed by nondetect results and decreased method detection limits are to be expected, and are not indicative of a real trend.

SDTs in cis-1,2-DCE concentrations were identified in wells SFL92-401 and SFL94-04B. Statistical outliers were identified in well SFL92-401 in 2007 and in well SFL92-601 in 2000. Removal of the outliers did not affect the statistical results. No SITs, SSIs or SSDs were identified in the data.

3.4.5 PCE

SDTs were identified for PCE concentrations in wells SFL92-301, SFL92-401, SFL92-403, SFL92-601, and SFL92-603. However, due to the reporting limits for VOCs being low, occasional detections followed by nondetect results, and decreased method detection limits are to be expected, and are not indicative of a real trend. No SITs, SSIs or SSDs were identified in the PCE dataset.

3.4.6 TCE

TCE is an associated LTMC. SDTs in TCE concentrations were identified in wells SFL92-301 and SFL92-403. However, due to the reporting limits for VOCs being low, occasional detections followed by nondetect results, and decreased method detection limits are to be expected, and are not indicative of a real trend. No SITs, SSIs or SSDs were identified in the TCE dataset.

3.4.7 Vinyl Chloride

Vinyl chloride is an LTMC. SDTs were identified in wells SFL92-401, SFL92-601, SFL94-04B, and SFL94-603. SDTs were also identified in SFL92-301, SFL94-02A, and SFL97-903. However, these were due to decreasing detection limits of nondetects and are not indicative of real trends. No SSIs or SSDs were identified in the vinyl chloride dataset.

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4.0 EFFECT OF HYDROLOGIC CONDITIONS ON CONTAMINANT TRANSPORT

Because of its location adjacent to the Kansas River, FTRI-003 contaminants may be mobilized during changing hydrologic conditions and transported by groundwater flow to points of discharge. USGS monitoring of the river stage, SWLs, and precipitation was discontinued in 2011. Figure 2-1 in Appendix B shows the relationship between precipitation and SWLs.

4.1 CONTAMINANT TRANSPORT WITHIN FTRI-003

Before the landfill was capped in 1995/1996, precipitation infiltrating through the soil cover and landfill wastes may have mobilized some contaminants prior to and during the addition of soil cover in 1995 and 1996. The primary initial process of contaminant mobilization at the FTRI-003 had been postulated to be the rise and fall of groundwater into and out of landfill wastes (Law Environmental, 1993). Once mobilized and incorporated into groundwater, contaminants generally migrate in the direction of groundwater flow. Groundwater would likely be in contact with landfill wastes at groundwater levels higher than 1,034 ft amsl, the approximate bottom of the landfill trenches (Law Environmental, 1993).

During the July 1993 Kansas River flood, the entire thickness of the alluvial aquifer was saturated when the landfill surface was inundated by floodwater. Water levels during the July 1993 flood rose above 1,052 ft amsl (the approximate land surface elevation at monitoring well SFL92-601 in 1993), or more than 18 ft above the bottom of the landfill trenches. Flooding, such as the July 1993 storm event, likely plays an important role in mobilizing groundwater contaminants at the FTRI-003.

The direction of groundwater flow is affected regionally by the stage of the Kansas River and locally by Three Mile Creek. The extent to which Kansas River stage affects groundwater flow is related to the magnitude and duration of stage changes in the river. When the Kansas River stage at the Henry River Bridge is less than approximately 1,038.50 ft amsl, the Three Mile Creek downstream stage at the TMCD gauging station does not appear to be affected. When the Kansas River Stage at the Henry River Bridge is more than approximately 1,046.00 ft amsl, the Three Mile Creek stage at TMCM gauging station, located approximately 2,000 feet from the Kansas River, begins to show backwater effects (USGS, 1999).

The larger the magnitude and duration of stage increases, the more effect the river will have on groundwater flow at FTRI-003. Large stage increases (5 ft or more) cause northeasterly to easterly groundwater flow. Because large stage increases are infrequent, the corresponding northeasterly to easterly groundwater flow at FTRI-003 is also likely to be infrequent. Northeasterly to easterly groundwater flow, therefore, is assumed to occur less frequently than the predominant southerly or southeasterly groundwater flow. Locally, water infiltrating the aquifer from Three Mile Creek could mix with and dilute the concentrations of contaminants in the shallow groundwater or force shallow groundwater to flow deeper in the aquifer.

The site flow characteristics make it likely that contaminants mobilized from the FTRI-003 will eventually discharge to the Kansas River, if not first degraded by natural attenuation processes to undetectable levels (USGS, 1999).

4.2 DISTRIBUTION OF LTMCs IN GROUNDWATER IN 2016

As shown on Table 3.3 and Figure 3.2, the distribution of detectable levels of LTMC VOCs in groundwater is limited to monitoring well SFL92-601. Monitoring well SFL92-601 is centrally located in the landfill and had a detection of benzene in May 2016 of 2.3 μg/L.

The May 2016 groundwater monitoring results combined with the historical interpretation of previous groundwater sampling events indicates that the dominant direction of contaminant migration at the FTRI-003 appears to be south to southeast toward the Kansas River. Three Mile Creek appears to be a barrier to eastward migration in the shallow alluvium. Contamination in the deeper alluvium apparently can migrate beneath the creek to deep wells SFL94-04B, and SFL97-903, based on historical analytical results. This, however, has not been a consistent historical occurrence, and VOC concentrations in these two wells in 2007 and 2008 were nondetect in comparison to deep well SFL92-603 (within the landfill). In 2009, chloromethane was detected is well SFL94-04B at 0.18J μg/L and vinyl chloride was detected at 0.39J μg/L). No VOCs were detected in this well in 2016. On the east side of Three Mile Creek, contaminants migrating from FTRI-003 in the deeper alluvium may be naturally attenuated to undetectable levels before reaching the Kansas River.

5.0 SUMMARY AND CONCLUSIONS

This section presents summary and conclusions for the surface water hydrology and the hydrogeology, analytical results, and statistical analysis results for the May 2016 groundwater sampling event at the FTRI-003.

5.1 INSPECTIONS

The monitoring well inspections indicate that the LTM wells are generally in good repair with the exception of some minor issues noted. HGL made minor repairs to the casing and one bollard at SFL92-601 as described in Section 3.2.2.2. Most of the wells are in need of vegetation clearance from around the wells, and all of the wells need to be painted.

The landfill inspection indicates that the landfill cover is generally in good condition and vegetation has been observed on all the former trench locations. However, the FTRI agronomist requested that any areas that have less than 1 plant per square foot be overseeded with the current CPR mix for Riley County at the appropriate time this fall.

5.2 SURFACE WATER HYDROLOGY AND HYDROGEOLOGIC CONDITIONS

Collection of data by the USGS at the FTRI-003 was stopped in 2011. Thus, continuous monitoring data for wells SFL92-301 and SFL94-06A and stream gauging stations located along Three Mile Creek is no longer available for making comparisons of Kansas River stage, precipitation, stream stages, and SWLs. Appendix B includes the last table (Table 2-1) and figure (Figure 2-1) generated with data from the USGS.

During May 2016, the general groundwater flow direction across FTRI-003 was south, toward the Kansas River. The hydraulic gradient was 0.00085 (4.5 ft/mi) measured between SFL94-05A and SFL92-201.

5.3 ANALYTICAL RESULTS

5.3.1 LTMCs

The LTMCs discussed in the Record of Decision (ROD) (EPA, 1995) for FTRI-003 are benzene, vinyl chloride, and lead. Vinyl chloride is a possible degradation product of 1,2-DCE (total), PCE, and TCE; therefore, DCE, PCE, and TCE results are evaluated in this report as associated LTMCs. Lead analysis was discontinued at FTRI-003 in 2007.

Benzene was detected in well SFL92-601 at 2.3 μg/L during the May 2016 sampling event. The concentration is below the MCL and RSK of 5.0 μg/L. Benzene concentrations were reported at wells SFL92-601 and SFL92-301 the last time they were sampled in 2013 (HGL, 2014b) at 2.0 μg/L and 0.59 J μg/L, respectively.

Vinyl chloride was not detected during the 2016 sampling event. In the previous sampling event in 2013 (HGL, 2014b), vinyl chloride was detected in well SFL92-601 at 0.48 J μg/L, which is less than the MCL and RSK of 2.0 μg/L.

The associated LTMCs, TCE, PCE, cis-1,2-DCE, and trans-1,2-DCE were not detected during the May 2016 groundwater sampling event.

5.3.2 Non-LTMC Volatile Organic Compounds

In May 2016, 1,1-dichloroethane, chlorobenzene, isopropylbenzene, and PDB were detected in well SFL92-601 at concentrations less than their respective MCLs and KDHE RSKs. Monitoring well SFL92-601 is screened in the shallow aquifer in the central portion of the landfill (Figure 1.2). Additionally, chlorobenzene was detected in wells SFL92-301, SFL92-401 and SFL92-403, and PDB was detected in well SFL92-301. These VOCs are not LTMCs or associated LTMCs. Historical detections for non-LTMC VOCs are consistently at low concentrations when detected at FTRI-003. Because VOC detection limits tend to be very low, variation in the list of VOCs reported as detected is expected.

5.4 STATISTICAL RESULTS

The statistical evaluation of the 2016 groundwater data was conducted in accordance with the methods recommended by the FTRI-003 LTGMP, EPA, and ASTM. Statistical analyses were performed (where sufficient data was available) on all constituents that were previously identified as LTMCs and associated LTMCs. Intrawell comparison tests, where concentration level comparisons are made within the same well, were performed on the nine monitoring wells sampled in May 2016. Results are summarized in Table 3.6

5.5 CONCLUSIONS

VOCs were reported at reportable levels only in wells SFL92-301, SFL92-401, SFL92-403 and SFL92-601. All compounds were detected below their respective MCL and KDHE RSK. The May 2016 groundwater monitoring results combined with the historical interpretation of previous groundwater sampling events indicates that the dominant route for contaminant migration at the SFL appears to be south to southeast toward the Kansas River. Three Mile Creek appears to be a barrier to eastward migration in the shallow alluvium. Contamination in the deeper alluvium apparently can migrate beneath the creek to deep wells SFL94-04B, and SFL97-903, based on historical analytical results. No VOC compounds were detected east of the creek in 2016.

The following text is a brief presentation of the effectiveness of the remedy and the state of risk assessment at FTRI-003 summarized from Section VI (Technical Assessment) of the Five-Year Review Report, Installation Restoration Program, Fort Riley, Kansas, (FTRI, 2002).

> *The selected remedy at SFL (removal action, annual inspections and periodic maintenance, limitation of site access, and LTM) is functioning as intended. LTM indicates that groundwater concentrations for all VOCs except vinyl chloride have shown*

> *no long term increases and, in fact, are decreasing. Detections of vinyl chloride continually remain above the MCL. A risk assessment was performed as part of the SFL Remedial Investigation (Law Environmental, 1993). During the period between 1993 (risk assessment) and 2002 (Five-Year Review), EPA revised the carcinogenic and noncarcinogenic toxicity values for vinyl chloride, resulting in a decrease in the specified chemical toxicity for this compound. EPA data indicate that vinyl chloride is too readily volatilized in surface water to undergo bioaccumulation, except in extreme exposure conditions and high concentrations of contaminants. The bioaccumulation factor for vinyl chloride, the main contaminant of concern at the SFL measured in groundwater at concentrations above the MCL, indicates that vinyl chloride is not expected to significantly bioconcentrate in aquatic organisms. As such, food chain human health is not of concern (EPA, 2005).*

The following text is a summary of the effectiveness of the remedy and the state of risk assessment at FTRI-003 based on Section VII (Technical Assessment) of the Second Five-Year Review Report, Installation Restoration Program, Fort Riley, Kansas (FTRI, 2007).

> *The selected remedy at SFL including original landfill cover repairs and improvements and construction of the riverbank stabilization structure were effective in achieving the remedial objectives of the ROD. Institutional controls have been implemented through an Institutional Controls Plan and Real Property Master Plan (RPMP). The native grass evapotranspirative cover has assisted in maintaining the levels of potential chemicals of concern in the groundwater at low and mainly below MCL concentrations over time. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy are still valid. Vapor intrusion from impacted soil or groundwater is an exposure pathway that was not evaluated as part of the Baseline Risk Assessment (BLRA). Since land use is restricted by the RPMP, there are no receptors and this potential exposure pathway, as those evaluated in the BLRA, remains incomplete. No other information about environmental risks, site conditions, natural disaster impacts, or other data has been determined to affect the protectiveness of the remedy.*

The following text is a summary of the effectiveness of the remedy and the state of risk assessment at FTRI-003 based on Section VII (Technical Assessment) of the Third Five-Year Review Report, Installation Restoration Program, Fort Riley, Kansas (FTRI, 2012).

> *There were no opportunities for optimization identified during this review for the SFL, beyond those already identified. The monitoring well network provides sufficient data to assess the groundwater quality. Maintenance on the native grass and soil cover is sufficient to maintain its integrity. Major repairs are planned for 2013. Based on groundwater sampling results, the current condition of ponding and subsidence is not causing an increase in leaching of contaminants into the alluvial aquifer. The Remedial Action Completion Report (RACR) documenting completion of remedial action at the SFL states that seventeen years (1992-2009) of data reveal that no concentrations of contaminants from the SFL remain in the groundwater to threaten human health or the environment. Ongoing site inspection and maintenance has been reduced to an adequate*

> *and cost-effective level. The RACR was signed by the USEPA in February 2010, documenting that the SFL is eligible for "site completion" status under CERCLA and is a valid candidate for deletion from the NPL.*

Additionally, environmental risk from FTRI-003 has not increased because exposure pathways for existing contaminants remain incomplete and contaminant levels remain below MCLs. No information about environmental risks, site conditions, natural disaster impacts, or other data has been determined to affect the protectiveness of the remedy.

5.6 RECOMMENDATIONS

Based on the May 2016 groundwater sampling results and the analysis of data performed for this report, the continuation of monitoring is appropriate until monitoring activities at FTRI-003 are formally terminated. The FTRI-003 Remedial Action Completion Report specifies that if the contaminant concentrations in groundwater remain less than the MCLs, the Department of Army, Fort Riley, will evaluate the current and future conditions at FTRI-003 landfill and request approval from the EPA and the KDHE for formal termination of the groundwater monitoring program based on 33 years of post-closure (1983) and 19 years of post-ROD groundwater monitoring data for the FTRI-003 landfill from 1997 (the date the ROD for FTRI-003 was signed) to 2016. The May 2016 groundwater sampling event analytical laboratory results will be used for the preparation of the Five-Year Review in 2017.

6.0 REFERENCES

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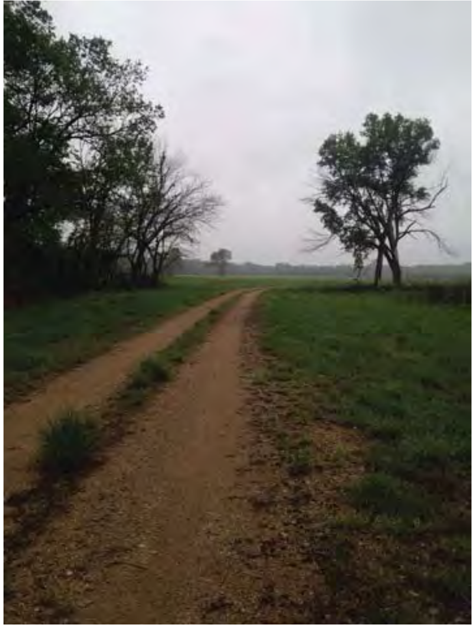
FTRI-003
Ft. Riley, Kansas



Photograph No.:1	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 10:18:00 AM	Project No.:K10004.03.02.00.00

Description: Inspection of SW Funston Landfill began at 1015.

Photograph No.: 2	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: East-Southeast	Time: 10:20:00 AM	Project No.:K10004.03.02.00.00

Description: View of the northeast section of the landfill, where several filled in trenches are located.

FTRI-003
Ft. Riley, Kansas

Photograph No.:3	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 10:24:00 AM	Project No.:K10004.03.02.00.00

Description: View of the sparse vegetation located on several of the filled in trenches on the east side of the landfill.

Photograph No.: 4	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 10:30:00 AM	Project No.:K10004.03.02.00.00

Description: View of an area of an area with sparse vegetation located on the end of a filled in trench.

FTRI-003
Ft. Riley, Kansas

Photograph No.:5	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 10:33:00 AM	Project No.:K10004.03.02.00.00

Description: View of the drainage area located on the east-central section of the landfill.

Photograph No.: 6	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 10:41:00 AM	Project No.:K10004.03.02.00.00

Description: View of a repaired trench located with new vegetation along the east side of the landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:7	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 10:34:00 AM	Project No.:K10004.03.02.00.00

Description: View of some debris located near the drainage area on the east side of the landfill.

Photograph No.: 8	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: North	Time: 10:38:00 AM	Project No.:K10004.03.02.00.00

Description: View of the former ponding areas on the east side of the landfill. Vegetation was observed.

FTRI-003
Ft. Riley, Kansas

Photograph No.:9	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 10:43:00 AM	Project No.:K10004.03.02.00.00

Description: View of new vegetation located on the southeast section of the landfill.

Photograph No.: 10	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 10:51:00 AM	Project No.:K10004.03.02.00.00

Description: View of the filled in trenches located on the south side of the landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:11	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 10:57:00 AM	Project No.:K10004.03.02.00.00

Description: View of the rip rap area located on the south side of the landfill, which remains in good condition.

Photograph No.: 12	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: East	Time: 11:05:00 AM	Project No.:K10004.03.02.00.00

Description: Observed new grass growth located on the south side of the landfill near the Kansas River.

FTRI-003
Ft. Riley, Kansas

Photograph No.:13	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 11:09:00 AM	Project No.:K10004.03.02.00.00

Description: Observed some debris located on the south side of the landfill by the Kansas River.

Photograph No.: 14	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: North	Time: 11:18:00 AM	Project No.:K10004.03.02.00.00

Description: Began to inspect the West side of the landfill along the road.

FTRI-003
Ft. Riley, Kansas

Photograph No.:15	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Northeast	Time: 11:23:00 AM	Project No.:K10004.03.02.00.00
Description: View of a small area of sparse vegetation located along the east central section of the road.			

Photograph No.: 16	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 11:27:00 AM	Project No.:K10004.03.02.00.00
Description: View of the signage for the landfill located near the entrance at FTRI-003.			

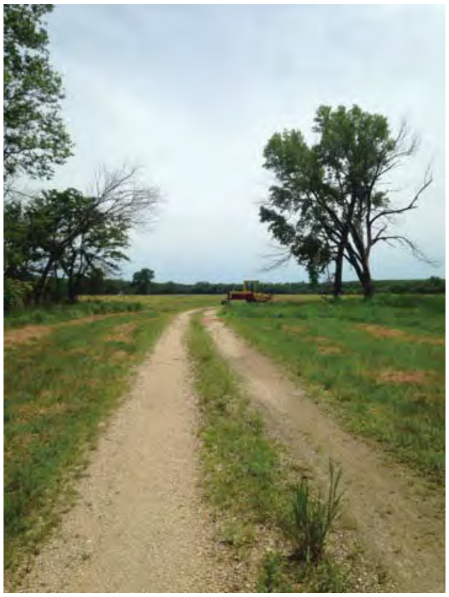
FTRI-003
Ft. Riley, Kansas

Photograph No.:17	Photographer: W. Webster	Date: 05-16-2016	Contract: W912DQ-13-D-3000
	Direction: Southwest	Time: 11:28:00 AM	Project No.:K10004.03.02.00.00

Description: Inspection of the landfill concluded at 1130.

End

FTRI-003
Ft. Riley, Kansas



Photograph No.:1	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 02:03:00 PM	Project No.:K10004.03.02.00.00

Description: W. Webster arrived on site to inspect the SW Funston Landfill for vegetation.

Photograph No.: 2	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:06:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the Northeast section of the landfill.The landfill had been cut for hay.

FTRI-003
Ft. Riley, Kansas

Photograph No.:3	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:08:00 PM	Project No.:K10004.03.02.00.00

Description: View of vegetation growing on a former trench located on the Northeast side of the landfill.

Photograph No.: 4	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:09:00 PM	Project No.:K10004.03.02.00.00

Description: The far east section of the landfill remained unmowed. View of an unmowed section of a former trench.

FTRI-003
Ft. Riley, Kansas

Photograph No.:5	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 02:10:00 PM	Project No.:K10004.03.02.00.00

Description: View of the mowed and unmowed section on the east side of the landfill. Vegetation was observed on the former trenches located on the Northeast section of the landfill.

Photograph No.: 6	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: South	Time: 02:11:00 PM	Project No.:K10004.03.02.00.00

Description: View of the typical amount of vegetation growing on the former trench areas at the landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:7	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:16:00 PM	Project No.:K10004.03.02.00.00
Description: View of the vegetation growing on the trench located on the east side of the landfill near the rip-rap area.			

Photograph No.: 8	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:18:00 PM	Project No.:K10004.03.02.00.00
Description: View overlooking the former ponding area located on the east side of the SW Funston landfill.			

FTRI-003
Ft. Riley, Kansas

Photograph No.:9	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: Southeast	Time: 02:20:00 PM	Project No.:K10004.03.02.00.00

Description: View of vegetation located on the former ponding area at the SW Funston Landfill.

Photograph No.: 10	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: East	Time: 02:21:00 PM	Project No.:K10004.03.02.00.00

Description: A closer look of the vegetation growing on the former ponding area.

FTRI-003
Ft. Riley, Kansas

Photograph No.:11	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: South	Time: 02:26:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the former trench areas in the southeast section of the landfill.

Photograph No.: 12	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: South	Time: 02:31:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the trench area located on the south of the landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:13	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: North	Time: 02:34:00 PM	Project No.:K10004.03.02.00.00

Description: View of the landfill looking north along the road.

Photograph No.: 14	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: West	Time: 02:40:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the former trench area located on the southwest side of the landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:15	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: Northwest	Time: 2:43:00 PM	Project No.:K10004.03.02.00.00

Description: View of the Northwest section of the landfill and the vegetation growing.

Photograph No.: 16	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: West	Time: 02:46:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the soil used to fill in the trenches on the west side of landfill.

FTRI-003
Ft. Riley, Kansas

Photograph No.:17	Photographer: W. Webster	Date: 07-14-2016	Contract: W912DQ-13-D-3000
	Direction: West	Time: 02:50:00 PM	Project No.:K10004.03.02.00.00

Description: View of the vegetation growing on the northwestern trench at the landfill.

Photograph No.: 18	Photographer: W. Webster	Date: 07-14-20166	Contract: W912DQ-13-D-3000
	Direction: West	Time: 02:50:00 PM	Project No.:K10004.03.02.00.00

Description: A closer look at the vegetation growing on the most northwestern trench at the landfill.

APPENDIX G

DRY CLEANING FACILITIES AREA

OU 003

BACKGROUND INFORMATION

- **ANALYTICAL TABLES**
- **STATISTICAL ANALYSIS**
- **2016 ANNUAL SITE INSPECTION**

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Table 3-1
Detected Compounds
2013 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			DCF92-01	DCF92-05	DCF93-13	DCF93-19	DCF93-20	DCF96-27
Date Sampled:	**Units**	**MCL**	**5/9/2013**	**5/16/2013**	**5/16/2013**	**5/16/2013**	**5/9/2013**	**5/12/2013**
GC/MS Volatiles (SW846 8260B)								
n-Butylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	**0.22 J**	0.20 U	0.20 U
sec-Butylbenzene	ug/l	--	0.21 U	0.21 U	0.21 U	**2.0**	0.21 U	0.21 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	**2.1**	0.29 U	0.29 U
cis-1,2-Dichloroethylene	ug/l	70	0.24 U	0.24 U	**14.3**	**13.1**	**12.3**	**28.6**
o-Dichlorobenzene	ug/l	--	0.22 U	0.22 U	0.22 U	**0.53 J**	0.22 U	0.22 U
trans-1,2-Dichloroethylene	ug/l	100	0.23 U	0.23 U	**0.45 J**	0.23 U	0.23 U	**0.26 J**
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	**1.5**	0.20 U	0.20 U
n-Propylbenzene	ug/l	--	0.23 U	0.23 U	0.23 U	**0.67 J**	0.23 U	0.23 U
Tetrachloroethylene	ug/l	5	0.32 U	**5.0**	**0.71 J**	0.32 U	**4.0**	**0.93 J**
Trichloroethylene	ug/l	5	0.31 U	0.31 U	**0.61 J**	**0.38 J**	**5.1**	**2.0**
Vinyl chloride	ug/l	2	0.44 U	0.44 U	**4.3**	**1.3**	0.44 U	**0.79 J**

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the method detection limit (MDL) and the reporting limit (RL).

J- Indicates the compound was detected above the MDL but below the RL and the value is estimated.

Table 3-1
Detected Compounds
2013 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			**DCF99-37C**	**DCF99-38C**	**DCF00-34C**	**DCF02-41**	**DCF02-43**
Date Sampled:	**Units**	**MCL**	**5/10/2013**	**5/10/2013**	**5/12/2013**	**5/13/2013**	**5/10/2013**
GC/MS Volatiles (SW846 8260B)							
n-Butylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
sec-Butylbenzene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
cis-1,2-Dichloroethylene	ug/l	70	**4.0**	**4.2**	**1.6**	**83.9**	0.24 U
o-Dichlorobenzene	ug/l	--	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
trans-1,2-Dichloroethylene	ug/l	100	0.23 U	0.23 U	0.23 U	**1.6**	0.23 U
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	ug/l	--	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
Tetrachloroethylene	ug/l	5	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Trichloroethylene	ug/l	5	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
Vinyl chloride	ug/l	2	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the metho

J- Indicates the compound was detected above the MDL but bel

Table 3-1
Detected Compounds
2013 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			**DCF02-44A**	**DCF02-44C**	**DCF02-46A**	**DCF02-46C**	**DCF02-47C**
Date Sampled:	**Units**	**MCL**	**5/13/2013**	**5/13/2013**	**5/15/2013**	**5/15/2013**	**5/13/2013**
GC/MS Volatiles (SW846 8260B)							
n-Butylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
sec-Butylbenzene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
cis-1,2-Dichloroethylene	ug/l	70	**4.8**	**5.5**	**0.80 J**	0.24 U	**0.65 J**
o-Dichlorobenzene	ug/l	--	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
trans-1,2-Dichloroethylene	ug/l	100	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	ug/l	--	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
Tetrachloroethylene	ug/l	5	**25.5**	**27.5**	**3.9**	**0.33 J**	**6.4**
Trichloroethylene	ug/l	5	**3.8**	**3.7**	**1.2**	0.31 U	**0.68 J**
Vinyl chloride	ug/l	2	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the metho

J- Indicates the compound was detected above the MDL but bel

Table 3-1
Detected Compounds
2013 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			DCF02-48A	DCF02-48C	DCF02-49C	DCF03-50C	DCF06-25
Date Sampled:	**Units**	**MCL**	**5/12/2013**	**5/13/2013**	**5/12/2013**	**5/9/2013**	**5/15/2013**
GC/MS Volatiles (SW846 8260B)							
n-Butylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
sec-Butylbenzene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
cis-1,2-Dichloroethylene	ug/l	70	**7.8**	**1.6**	**4.1**	0.24 U	**8.5**
o-Dichlorobenzene	ug/l	--	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
trans-1,2-Dichloroethylene	ug/l	100	0.23 U	0.23 U	0.23 U	0.23 U	**0.25 J**
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	ug/l	--	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
Tetrachloroethylene	ug/l	5	0.32 U	**6.6**	0.32 U	0.32 U	**39.5**
Trichloroethylene	ug/l	5	**1.3**	**0.96 J**	0.31 U	0.31 U	**5.5**
Vinyl chloride	ug/l	2	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the metho

J- Indicates the compound was detected above the MDL but bel

Table 3-1
Detected Compounds
2013 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			**DCF06-40**	**354-99-11C**
Date Sampled:	**Units**	**MCL**	**5/16/2013**	**5/10/2013**
GC/MS Volatiles (SW846 8260B)				
n-Butylbenzene	ug/l	--	0.20 U	0.20 U
sec-Butylbenzene	ug/l	--	0.21 U	0.21 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U
cis-1,2-Dichloroethylene	ug/l	70	**28.4**	**4.4**
o-Dichlorobenzene	ug/l	--	0.22 U	0.22 U
trans-1,2-Dichloroethylene	ug/l	100	0.23 U	0.23 U
Isopropylbenzene	ug/l	--	0.20 U	0.20 U
n-Propylbenzene	ug/l	--	0.23 U	0.23 U
Tetrachloroethylene	ug/l	5	**0.60 J**	0.32 U
Trichloroethylene	ug/l	5	**0.88 J**	**0.46 J**
Vinyl chloride	ug/l	2	0.44 U	0.44 U

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the metho

J- Indicates the compound was detected above the MDL but bel

Table 3-1
Detected Compounds
2014 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Compound ID	Chloroform	cis-1,2-Dichloroethylene	trans-1,2-Dichloroethylene	Tetrachloroethylene	Trichloroethylene	Vinyl Chloride
Well ID MCL	--	*70 ug/L*	*100 ug/L*	*5 ug/L*	*5 ug/L*	*2 ug/L*
DCF92-01	**1.5**	0.33 U	0.34 U	0.26 U	0.30 U	0.33 U
DCF92-05	**0.31 J**	0.33 U	0.34 U	**3.4**	0.30 U	0.33 U
DCF93-13	0.31 U	**44.9**	**1.4**	0.26 U	**0.41 J**	**6.6**
DCF93-19	0.31 U	**5.9**	0.34 U	0.26 U	0.30 U	**0.95 J**
DCF93-20	**0.40 J**	**7.1**	0.34 U	**4.9**	**4.7**	0.33 U
DCF96-27	0.31 U	**18.5**	**0.38 J**	**4.1**	**2.1**	**0.63 J**
DCF99-37C	0.31 U	**3.6**	0.34 U	**0.26 J**	**0.32 J**	0.33 U
DCF99-38C	0.31 U	**2.2**	0.34 U	0.26 U	0.30 U	0.33 U
DCF00-34C	0.31 U	**0.95 J**	0.34 U	0.26 U	0.30 U	0.33 U
DCF02-41	0.31 U	**74.4**	**2.2**	0.26 U	0.30 U	**0.57 J**
DCF02-43	0.31 U	0.33 U	0.34 U	0.26 U	0.30 U	0.33 U
DCF02-44A	0.31 U	**6.0**	0.34 U	**22.3**	**3.9**	0.33 U
DCF02-44C	0.31 UJ	**5.8 J**	0.34 UJ	**22.0 J**	**3.7 J**	0.33 U J
DCF02-46A	0.31 U	0.33 U	0.34 U	0.26 U	0.30 U	0.33 U
DCF02-46C	0.31 U	0.33 U	0.34 U	**0.93 J**	0.30 U	0.33 U
DCF02-47C	0.31 U	0.33 U	0.34 U	**3.2**	0.30 U	0.33 U
DCF02-48C	0.31 U	**1.3**	0.34 U	**8.2**	**1.2**	0.33 U
DCF02-49C	0.31 U	**1.6**	0.34 U	0.26 U	0.30 U	0.33 U
DCF03-50C	0.31 U	0.33 U	0.34 U	0.26 U	0.30 U	0.33 U
DCF06-25	0.31 U	**5.2**	0.34 U	**37.6**	**3.9**	0.33 U
DCF06-40	0.31 U	**12.6**	0.34 U	**0.71 J**	**0.50 J**	0.33 U
354-99-11C	0.31 U	**4.0**	0.34 U	0.26 U	**0.31 J**	0.33 U

Notes:

Shade - VOC Compounds detected above MCL

Bold - VOC Compounds detected above method detection limit

U - Indicates the compound was not detected above the method detection limit (MDL) and the reporting limit (RL).

J- Indicates the compound was detected above the MDL but below the RL and the value is estimated.

Table 3-2
Analytical Laboratory Summary
2014 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			DCF06-40	DCF92-05	DCF93-13	DCF93-19	DCF92-01	DCF93-20	DCF00-34C	DCF02-41	DCF02-43	DCF02-44A	DCF02-44C	DCF02-46A
Date Sampled:	Units	MCL	4/30/2014	4/30/2014	4/30/2014	4/30/2014	4/24/2014	4/24/2014	4/27/2014	4/27/2014	4/27/2014	4/27/2014	4/27/2014	4/27/2014
GC/MS Volatiles (SW846 8260B)														
Acetone	ug/l	--	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
Benzene	ug/l	5	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Bromobenzene	ug/l	--	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
Bromochloromethane	ug/l	--	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U
Bromodichloromethane	ug/l	--	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U
Bromoform	ug/l	--	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U
n-Butylbenzene	ug/l	--	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U
sec-Butylbenzene	ug/l	--	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Chlorobenzene	ug/l	100	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Chloroethane	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	ug/l	--	0.31 U	**0.31 J**	0.31 U	0.31 U	**1.5**	**0.40 J**	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
o-Chlorotoluene	ug/l	--	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
p-Chlorotoluene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Carbon disulfide	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Carbon tetrachloride	ug/l	5	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
1,1-Dichloroethane	ug/l	--	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U
1,1-Dichloroethylene	ug/l	7	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloropropene	ug/l	--	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U
1,2-Dibromoethane	ug/l	0.05	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,2-Dichloroethane	ug/l	5	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,2-Dichloropropane	ug/l	5	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U
1,3-Dichloropropane	ug/l	--	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U
2,2-Dichloropropane	ug/l	--	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Dibromochloromethane	ug/l	--	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 UJ	0.36 U	0.36 U
Dichlorodifluoromethane	ug/l	--	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
cis-1,2-Dichloroethylene	ug/l	70	**12.6**	0.33 U	**44.9**	**5.9**	0.33 U	**7.1**	**0.95 J**	**74.4**	0.33 U	**6.0**	**5.8**	0.33 U
cis-1,3-Dichloropropene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
m-Dichlorobenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
o-Dichlorobenzene	ug/l	600	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
p-Dichlorobenzene	ug/l	75	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,2-Dichloroethylene	ug/l	100	0.34 U	0.34 U	**1.4**	0.34 U	0.34 U	0.34 U	0.34 U	**2.2**	0.34 U	0.34 U	0.34 U	0.34 U
trans-1,3-Dichloropropene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Ethylbenzene	ug/l	700	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U
2-Hexanone	ug/l	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Hexachlorobutadiene	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
p-Isopropyltoluene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
4-Methyl-2-pentanone	ug/l	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl bromide	ug/l	--	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U
Methyl chloride	ug/l	--	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U
Methylene bromide	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Methylene chloride	ug/l	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Methyl ethyl ketone	ug/l	--	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Methyl Tert Butyl Ether	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Naphthalene	ug/l	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Propylbenzene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Styrene	ug/l	100	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 UJ	0.23 U	0.23 U
1,1,1,2-Tetrachloroethane	ug/l	200	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1,1-Trichloroethane	ug/l	--	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U
1,1,2,2-Tetrachloroethane	ug/l	--	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
1,1,2-Trichloroethane	ug/l	5	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
1,2,3-Trichlorobenzene	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	ug/l	70	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trimethylbenzene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,3,5-Trimethylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 UJ	0.20 U	0.20 U
Tetrachloroethylene	ug/l	5	**0.71 J**	**3.4**	0.26 U	0.26 U	0.26 U	**4.9**	0.26 U	0.26 U	0.26 U	**22.3**	**22.0**	0.26 U
Toluene	ug/l	1000	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethylene	ug/l	5	**0.50 J**	0.30 U	**0.41 J**	0.30 U	0.30 U	**4.7**	0.30 U	0.30 U	0.30 U	**3.9**	**3.7**	0.30 U
Vinyl chloride	ug/l	2	0.33 U	0.33 U	**6.6**	**0.95 J**	0.33 U	0.33 U	0.33 U	**0.57 J**	0.33 U	0.33 U	0.33 U	0.33 U
m,p-Xylene	ug/l	--	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
o-Xylene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
GC Volatiles (RSKSOP-147/175)														
Methane	ug/l	--	**495**	**7.8**	**1320**	**410**	**7.6**	**20.3**	**37.4**	**111**	**7.6**	**7.7**	**7.6**	**7.6**
Ethane	ug/l	--	0.32 U	0.32 U	**0.33 J**	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Ethene	ug/l	--	0.43 U	0.43 U	**0.61 J**	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U
General Chemistry														
Alkalinity, Total as CaCO3	mg/l	--	**550**	**424**	**404**	**454**	**383**	**310**	**381**	**525**	**372**	**475**	**393**	**367**
Chloride	mg/l	250	**284**	**476**	**440**	**480**	**303**	**427**	**257**	**260**	**107**	**336**	**272**	**93.9**
Nitrogen, Nitrate	mg/l	10	**0.63 J**	**4.8**	0.50 U	0.50 U	**3.5**	**0.83 J**	0.25 U	0.50 U	**0.82**	**2.1**	**2.5**	**1.0**
Nitrogen, Nitrite	mg/l	1	0.50 U	0.50 U	0.50 U	0.50 U	0.25 U	0.50 U	0.25 U	0.50 U	0.25 U	0.50 U	0.25 U	0.25 U
Sulfate	mg/l	250	**172**	**120**	**118**	**30.7**	**136**	**238**	**199**	**275**	**141**	**140**	**143**	**122**
Sulfide	mg/l	--	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	**0.46 J**	**2.0**	**0.74 J**	0.22 U	**1.2**	0.22 U	0.22 U
Total Organic Carbon	mg/l	--	**2.1**	**1.8**	**1.8**	**2.0**	**67.7**	**51.8**	**57.8**	**107**	**63.8**	**87.7**	**83.2**	**67**

Table 3-2
Analytical Laboratory Summary
2014 Annual Groundwater Samplng Report
Dry Cleaning Facilities Area OU-003
Fort Riley, KS

Sample ID:			DCF02-46C	DCF02-47C	DCF02-48C	DCF02-49C	DCF06-25	DCF96-27	354-99-11C	DCF03-50C	DCF99-37C	DCF99-38C
Date Sampled:	**Units**	**MCL**	**4/27/2014**	**4/27/2014**	**4/27/2014**	**4/28/2014**	**4/27/2014**	**4/28/2014**	**4/25/2014**	**4/25/2014**	**4/25/2014**	**4/25/2014**
GC/MS Volatiles (SW846 8260B)												
Acetone	ug/l	--	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
Benzene	ug/l	5	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Bromobenzene	ug/l	--	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
Bromochloromethane	ug/l	--	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U
Bromodichloromethane	ug/l	--	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U
Bromoform	ug/l	--	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U
n-Butylbenzene	ug/l	--	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U
sec-Butylbenzene	ug/l	--	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
tert-Butylbenzene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Chlorobenzene	ug/l	100	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Chloroethane	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	ug/l	--	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
o-Chlorotoluene	ug/l	--	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
p-Chlorotoluene	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Carbon disulfide	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Carbon tetrachloride	ug/l	5	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
1,1-Dichloroethane	ug/l	--	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U	0.26 U
1,1-Dichloroethylene	ug/l	7	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloropropene	ug/l	--	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U
1,2-Dibromoethane	ug/l	0.05	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,2-Dichloroethane	ug/l	5	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,2-Dichloropropane	ug/l	5	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U
1,3-Dichloropropane	ug/l	--	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U
2,2-Dichloropropane	ug/l	--	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Dibromochloromethane	ug/l	--	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U
Dichlorodifluoromethane	ug/l	--	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
cis-1,2-Dichloroethylene	ug/l	70	0.33 U	0.33 U	**1.3**	**1.6**	**5.2**	**18.5**	**4.0**	0.33 U	**3.6**	**2.2**
cis-1,3-Dichloropropene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
m-Dichlorobenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
o-Dichlorobenzene	ug/l	600	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
p-Dichlorobenzene	ug/l	75	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,2-Dichloroethylene	ug/l	100	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	**0.38 J**	0.34 U	0.34 U	0.34 U	0.34 U
trans-1,3-Dichloropropene	ug/l	--	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Ethylbenzene	ug/l	700	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U
2-Hexanone	ug/l	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Hexachlorobutadiene	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Isopropylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
p-Isopropyltoluene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
4-Methyl-2-pentanone	ug/l	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl bromide	ug/l	--	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U
Methyl chloride	ug/l	--	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U
Methylene bromide	ug/l	--	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U	0.29 U
Methylene chloride	ug/l	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Methyl ethyl ketone	ug/l	--	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Methyl Tert Butyl Ether	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Naphthalene	ug/l	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Propylbenzene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Styrene	ug/l	100	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
1,1,1,2-Tetrachloroethane	ug/l	200	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1,1-Trichloroethane	ug/l	--	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U
1,1,2,2-Tetrachloroethane	ug/l	--	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
1,1,2-Trichloroethane	ug/l	5	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
1,2,3-Trichlorobenzene	ug/l	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	ug/l	70	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trimethylbenzene	ug/l	--	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
1,3,5-Trimethylbenzene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethylene	ug/l	5	**0.93 J**	**3.2**	**8.2**	0.26 U	**37.6**	**4.1**	0.26 U	0.26 U	**0.26 J**	0.26 U
Toluene	ug/l	1000	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethylene	ug/l	5	0.30 U	0.30 U	**1.2**	0.30 U	**3.9**	**2.1**	**0.31 J**	0.30 U	**0.32 J**	0.30 U
Vinyl chloride	ug/l	2	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	**0.63 J**	0.33 U	0.33 U	0.33 U	0.33 U
m,p-Xylene	ug/l	--	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
o-Xylene	ug/l	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
GC Volatiles (RSKSOP-147/175)												
Methane	ug/l	--	**7.6**	**7.6**	**8.7**	**2090**	**7.7**	**26.2**	**602**	**11.7**	**457**	**16.4**
Ethane	ug/l	--	0.32 U	0.32 U	0.32 U	3.2 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Ethene	ug/l	--	0.43 U	0.43 U	0.43 U	4.3 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U
General Chemistry												
Alkalinity, Total as CaCO3	mg/l	--	**379**	**352**	**383**	**359**	**458**	**466**	**371**	**251**	**404**	**375**
Chloride	mg/l	250	**115**	**134**	**172**	**199**	**417**	**288**	**459**	**91.7**	**305**	**174**
Nitrogen, Nitrate	mg/l	10	**1.7**	**1.5**	**2.5**	0.25 U	**5.0**	0.25 U	0.50 U	0.25 U	0.25 U	0.25 U
Nitrogen, Nitrite	mg/l	1	0.25 U	0.25 U	0.25 U	0.25 U	0.50 U	0.25 U	0.50 U	0.25 U	0.25 U	0.25 U
Sulfate	mg/l	250	**139**	**145**	**145**	**111**	**111**	**119**	**187**	**133**	**116**	**111**
Sulfide	mg/l	--	**0.74 J**	0.22 U	0.22 U	**0.28 J**	0.22 U	0.22 U	0.22 U	0.22 U	**1.9**	0.22 U
Total Organic Carbon	mg/l	--	**70.9**	**65.3**	**68.6**	**67.8**	**86**	**86.4**	**2.2**	**2.4**	**2.5**	**2.7**

Table 2.2
May 2015 Summary of Detections
2015 Long-Term Monitoring Report (FTRI-027)
Fort Riley, Kansas

Well ID			**DCF93-19**	**DCF93-13**	**DCF06-40**	**DCF92-05**	**05/14/15-DUP1**	**DCF92-01**	**05/14/15-DUP2**	**DCF02-42**	**DCF93-20**	**DCF02-43**	**DCF02-41**	**DCF03-50C**	**DCF02-46A**	**DCF02-46C**
Sample Date	**MCL**	**RSK**	**5/12/2015**	**5/13/2015**	**5/14/2015**	**5/14/2015**	**5/14/2015**	**5/14/2015**	**5/14/2015**	**5/14/2015**	**5/15/2015**	**5/18/2015**	**5/18/2015**	**5/19/2015**	**5/19/2015**	**5/19/2015**
Constituent	**μg/L**	**μg/L**														
VOCs																
tert-Butylbenzene (μg/L)	nsv	nsv	**1.9**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon Disulfide (μg/L)	nsv	716	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (μg/L)	80	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.74 J**	**0.77 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene (μg/L)	600	600	**0.45 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene (μg/L)	70	70	**6.5**	**58.0**	**14.4**	0.50 U	0.50 U	0.50 U	0.50 U	**2.7**	**5.0**	0.50 U	**62.1**	0.50 U	0.50 U	0.50 U
trans-1,2-Dichloroethene (μg/L)	100	100	0.50 U	**1.8**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**2.6**	0.50 U	0.50 U	0.50 U
Isoprophylbenzene (μg/L)	nsv	451	**0.53 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene (μg/L)	5	5	0.50 U	0.50 U	***7.0***	**3.7**	**3.9**	0.50 U	0.50 U	***22.2***	**2.2**	0.50 U	0.50 U	0.50 U	**0.43 J**	**0.46 J**
Trichloroethene (μg/L)	5	5	0.50 U	**0.27 J**	**1.7**	0.50 U	0.50 U	0.50 U	0.50 U	**2.3**	**2.3**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trimethylbenzene (μg/L)	nsv	8.44	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.30 J**	**0.32 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride (μg/L)	2	2	**1.1**	***5.7***	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Natural Attenuation Parameters																
Methane (μg/L)	nsv	nsv	**521**	**951**	**363**	0.25 U	**0.18 J**	0.25 U	0.25 U	0.25 U	**15.8**	**0.37 J**	**63.1**	**3.3**	**3.6**	0.25 U
Alkalinity, Total as $CaCO_3$ (mg/L)	nsv	nsv	**479**	**400**	**670**	**394**	**404**	**382**	**385**	**427**	**316**	**340**	**491**	**294**	**228**	**383**
Chloride (mg/L)	nsv	nsv	**576**	**450**	**304**	**476**	**462**	**352**	**336**	**725**	**419**	**117**	**289**	**122**	**108**	**105**
Nitrogen, Nitrate (mg/L)	nsv	nsv	0.50 U	0.50 U	0.50 U	**2.9**	**2.9**	**4.0**	**3.7**	**4.1**	1.3 U	**1.8**	0.25 U	0.25 U	**0.14 J**	**1.7**
Sulfate (mg/L)	nsv	nsv	**21.5**	**118**	**189**	**115**	**112**	**133**	**127**	**158**	**229**	**152**	**236**	**193**	**130**	**142**
Sulfide (mg/L)	nsv	nsv	0.23 U	0.24 U	**2.8**	0.24 U	**1.1**	**0.28 J**	0.24 U	**1.8**	0.24 U	0.25 U	**1.7**	**1.3**	0.24 U	**1.7**
Total Organic Carbon (mg/L)	nsv	nsv	**2.0**	**2.1**	**2.4**	**2.0**	**1.9**	**1.6**	**1.5**	**1.8**	**2.0**	**1.0**	**1.8**	**2.2**	**3.7**	**2.0**

Table 2.2 (continued)
May 2015 Summary of Detections
2015 Long-Term Monitoring Report (FTRI-027)
Fort Riley, Kansas

Well ID			**DCF02-47C**	**DCF02-48A**	**DCF02-48C**	**DCF02-49C**	**354-99-11C**	**DCF99-38C**	**05/20/15-DUP1**	**DCF99-37C**	**DCF02-44A**	**DCF02-44C**	**DCF00-34C**	**DCF96-27**	**DCF06-25**
Sample Date	**MCL**	**RSK**	**5/19/2015**	**5/20/2015**	**5/20/2015**	**5/20/2015**	**5/20/2015**	**5/20/2015**	**5/20/2015**	**5/20/2015**	**5/21/2015**	**5/21/2015**	**5/21/2015**	**5/22/2015**	**5/22/2015**
Constituent	**μg/L**	**μg/L**													
VOCs															
tert-Butylbenzene (μg/L)	nsv	nsv	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon Disulfide (μg/L)	nsv	716	1.0 U	**1.6 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (μg/L)	80	80	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.95 J**	0.50 U	0.50 U	**0.94 J**
1,2-Dichlorobenzene (μg/L)	600	600	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene (μg/L)	70	70	0.50 U	**4.2**	**0.31 J**	**3.6**	**2.6**	**0.39 J**	**0.49 J**	**7.3**	**5.9**	**4.0**	**0.78 J**	**19.4**	**4.1**
trans-1,2-Dichloroethene (μg/L)	100	100	0.50 U	**0.23 J**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.23 J**	**0.26 J**	0.50 U	0.50 U	**0.44 J**	0.50 U
Isoprophylbenzene (μg/L)	nsv	451	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene (μg/L)	5	5	**1.3**	**1.1**	**3.8**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***21.0***	***23.3***	0.50 U	**1.9**	***31.9***
Trichloroethene (μg/L)	5	5	0.50 U	**0.95 J**	**0.43 J**	**1.0**	**0.27 J**	0.50 U	0.50 U	0.50 U	**4.3**	**2.9**	0.50 U	**1.1**	**3.7**
1,2,4-Trimethylbenzene (μg/L)	nsv	8.44	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride (μg/L)	2	2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.43 J**	0.50 U
Natural Attenuation Parameters															
Methane (μg/L)	nsv	nsv	0.25 U	**9.9**	**0.34 J**	**402**	**2580**	**37.5***	**32.3**	**34.4**	**0.32 J**	**0.20 J**	**96.4**	**18.7**	0.25 U
Alkalinity, Total as CaCO$_3$ (mg/L)	nsv	nsv	**363**	**350**	**341**	**391**	**388**	**246**	**247**	**481**	**440**	**416**	**409**	**435**	**427**
Chloride (mg/L)	nsv	nsv	**124**	**209**	**189**	**227**	**455**	**211**	**213**	**264**	**343**	**302**	**299**	**286**	**409**
Nitrogen, Nitrate (mg/L)	nsv	nsv	**2.0**	0.25 U	**1.7**	0.25 U	0.50 U	0.25 U	0.25 U	0.25 U	**2.6**	**5.0**	0.25 U	0.25 U	**5.2**
Sulfate (mg/L)	nsv	nsv	**150**	**189**	**172**	**140**	**138**	**173**	**175**	**35.7**	**143**	**132**	**214**	**120**	**121**
Sulfide (mg/L)	nsv	nsv	0.24 U	0.24 U	**0.64 J**	**1.6**	**0.41 J**	**2.3**	0.24 U	0.24 U	**0.74 J**	**1.6**	**0.95**	**1.9**	**1.4**
Total Organic Carbon (mg/L)	nsv	nsv	**1.2**	**2.5 J**	**1.5 J**	**1.8 J**	**3.6 J**	**2.7 J**	**2.6 J**	**1.8 J**	**1.9**	**1.4**	**1.8**	**2.3**	**1.5**

Notes:

[1] The individual trihalomethanes (bromodichloromethane; bromoform; dibromochloromethane, chloroform) all have the MCL of 80 μg/L listed in the RSL table. However, 80 μg/L is the MCL for Total Trihalomethanes.

* Laboratory reported result as 4850 E μg/L, but had run a second and third run at 10x with results of 37.5 μg/Land 33.7 μg/L, respectively (see Data Challenge Response in Appendix A). HGL chemist has designated the 4850 E result as an outlier and recommended reporting the result as 37.5 μg/L.

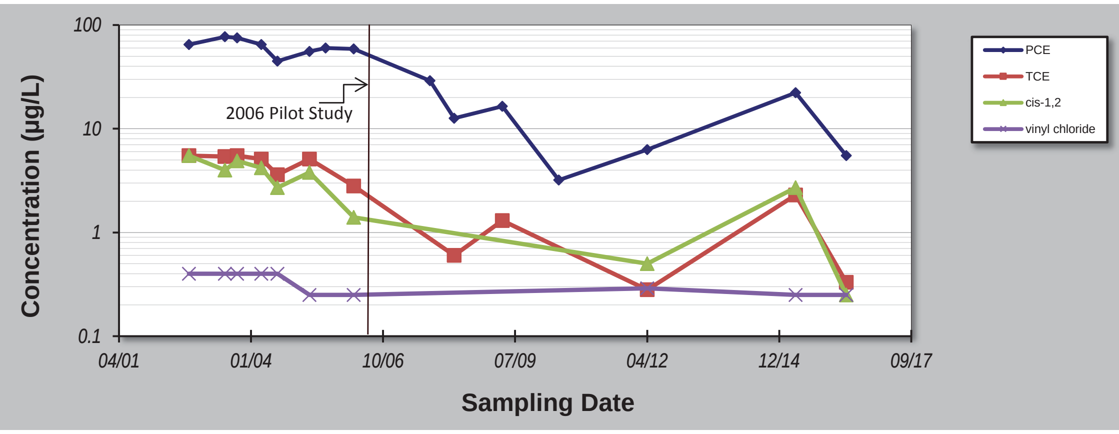
BOLD = detection
Italics = detected concentration above RSK
Shading = detected concentration is above the MCL or RSK.
CaCO$_3$ = calcium carbonate
ID = identification
J = The analyte was detected at the reported concentration; the quantitation is an estimate.
MCL = maximum contaminant level
μg/L = micrograms per liter
mg/L = milligrams per liter
nsv = no screening value
RSK = Risk-Based Standards for Kansas
TOC = total organic carbon
U = Not detected. The associated number indicates the analyte limit of detection.
UJ =Not detected. The associated number indicates the analyte limit of detection, which may be inaccurate.
VOC = volatile organic compound

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF02-42**
Concentration Units: **µg/L**

Sampling Event	Sampling Date	PCE	TCE	cis-1,2	vinyl chloride			
		DCF02-42 CONCENTRATION (µg/L)						
1	10/1/2002	**64.9**	**5.5**	**5.5**	*0.4*			
2	7/1/2003	**77.0**	**5.4**	**4**	*0.4*			
3	10/1/2003	**75.1**	**5.5**	**4.9**	*0.4*			
4	4/1/2004	**64.9**	**5.1**	**4.2**	*0.4*			
5	8/1/2004	**44.8**	**3.6**	**2.7**	*0.4*			
6	4/1/2005	**55.7**	**5.1**	**3.8**	*0.25*			
7	8/1/2005	**60.1**						
8	3/1/2006	**58.9**	**2.8**	**1.4**	*0.25*			
9	10/1/2007	**29.1**						
10	4/1/2008	**12.6**	**0.6**					
11	4/1/2009	**16.5**	**1.3**					
12	6/1/2010	**3.2**						
13	4/1/2012	**6.3**	**0.28**	*0.5*	**0.29**			
14	5/1/2015	**22.2**	**2.3**	**2.7**	*0.25*			
15	5/18/2016	**5.5**	**0.33**	*0.25*	*0.25*			
16								
17								
18								
19								
20								
Coefficient of Variation:		0.68	0.68	0.60	0.23			
Mann-Kendall Statistic (S):		-76	-50	-34	-25			
Confidence Factor:		>99.9%	>99.9%	100.0%	98.6%			
Concentration Trend:		Decreasing	Decreasing	Decreasing	Decreasing			



Notes:

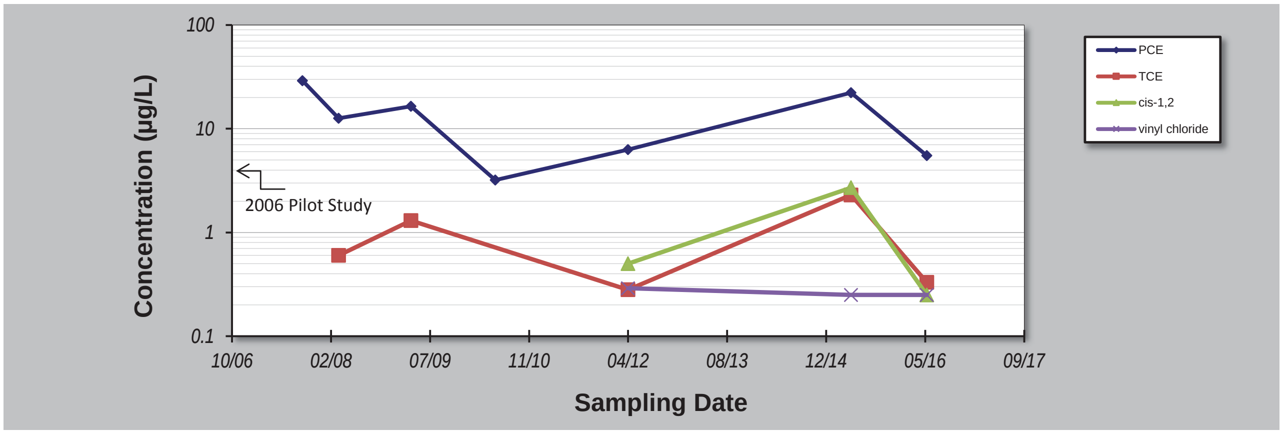
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF02-42 Post 2006 Pilot Studies**
Concentration Units: **μg/L**

	Sampling Point ID:	**PCE**	**TCE**	**cis-1,2**	**vinyl chloride**			
Sampling Event	Sampling Date	DCF02-42 POST 2006 PILOT STUDIES CONCENTRATION (µg/L)						
1	10/1/2007	**29.1**						
2	4/1/2008	**12.6**	**0.6**					
3	4/1/2009	**16.5**	**1.3**					
4	6/1/2010	**3.2**						
5	4/1/2012	**6.3**	**0.28**	*0.5*	**0.29**			
6	5/1/2015	**22.2**	**2.3**	**2.7**	*0.25*			
7	5/18/2016	**5.5**	**0.33**	*0.25*	*0.25*			
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
	Coefficient of Variation:	0.70	0.89	1.17	0.09			
	Mann-Kendall Statistic (S):	-7	0	-1	-2			
	Confidence Factor:	80.9%	40.8%					
	Concentration Trend:	Stable	Stable					



Notes:

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2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
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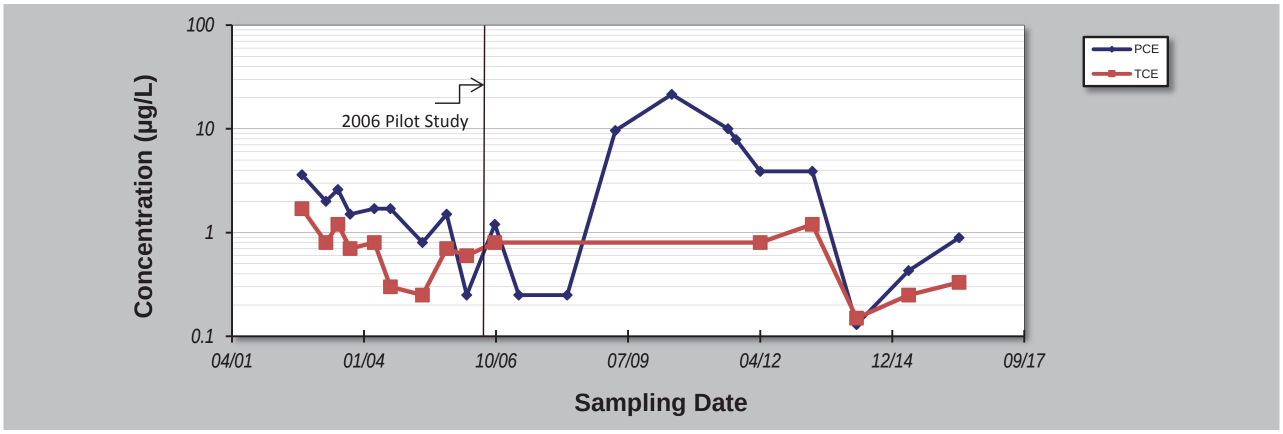
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF02-46A**
Concentration Units: **µg/L**

Sampling Event	Sampling Date	PCE	TCE					
Sampling Point ID:		**PCE**	**TCE**					
		DCF02-46A CONCENTRATION (µg/L)						
1	10/1/2002	**3.6**	**1.7**					
2	4/1/2003	**2**	**0.8**					
3	7/1/2003	**2.6**	**1.2**					
4	10/1/2003	**1.5**	**0.7**					
5	4/1/2004	**1.7**	**0.8**					
6	8/1/2004	**1.7**	**0.3**					
7	4/1/2005	**0.8**	**0.25**					
8	10/1/2005	**1.5**	**0.7**					
9	3/1/2006	*0.25*	**0.6**					
10	10/1/2006	**1.2**	**0.8**					
11	4/1/2007	*0.25*						
12	4/1/2008	*0.25*						
13	4/1/2009	**9.6**						
14	6/1/2010	**21.5**						
15	8/1/2011	**10**						
16	10/1/2011	**7.9**						
17	4/1/2012	**3.9**	**0.8**					
18	5/1/2013	**3.9**	**1.2**					
19	4/1/2014	*0.13*	0.15					
20	5/1/2015	**0.43**	0.25					
21	5/17/2016	**0.89**	**0.33**					
22								
23								
24								
25								
Coefficient of Variation:		1.41	0.61					
Mann-Kendall Statistic (S):		-24	-36					
Confidence Factor:		75.4%	95.9%					
Concentration Trend:		No Trend	Decreasing					



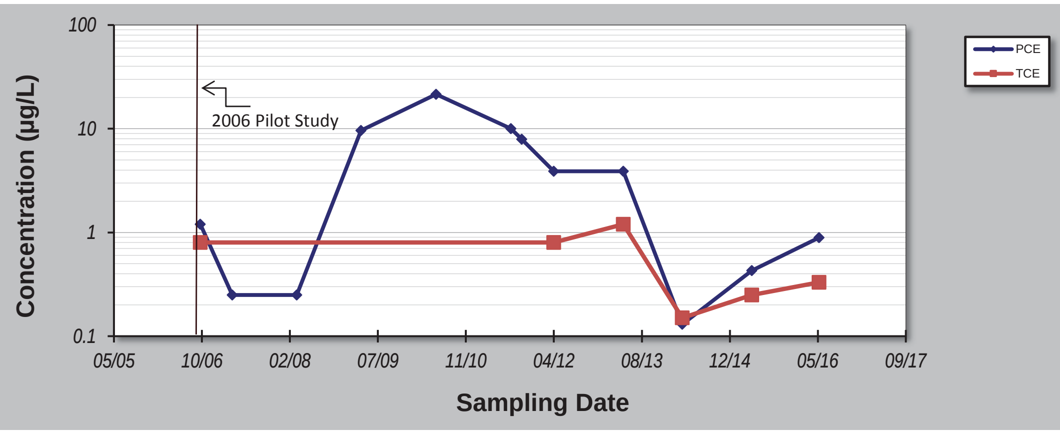
Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 6-Jul-16
Facility Name: HydroGeoLogic, Inc.
Conducted By: LV
Job ID: FTRI-027
Constituent: DCF02-46A Post 2006 Pilot Studies
Concentration Units: µg/L

	Sampling Point ID:	PCE	TCE					
Sampling Event	Sampling Date	DCF02-46A POST 2006 PILOT STUDIES CONCENTRATION (µg/L)						
1	10/1/2006	**1.2**	**0.8**					
2	4/1/2007	*0.25*						
3	4/1/2008	*0.25*						
4	4/1/2009	**9.6**						
5	6/1/2010	**21.5**						
6	8/1/2011	**10**						
7	10/1/2011	**7.9**						
8	4/1/2012	**3.9**	**0.8**					
9	5/1/2013	**3.9**	**1.2**					
10	4/1/2014	*0.13*	*0.15*					
11	5/1/2015	**0.43**	*0.25*					
12	5/17/2016	**0.89**	**0.33**					
13								
14								
15								
16								
17								
18								
19								
20								
	Coefficient of Variation:	1.28	0.70					
	Mann-Kendall Statistic (S):	-10	-4					
	Confidence Factor:	72.7%	70.3%					
	Concentration Trend:	No Trend	Stable					



Notes:

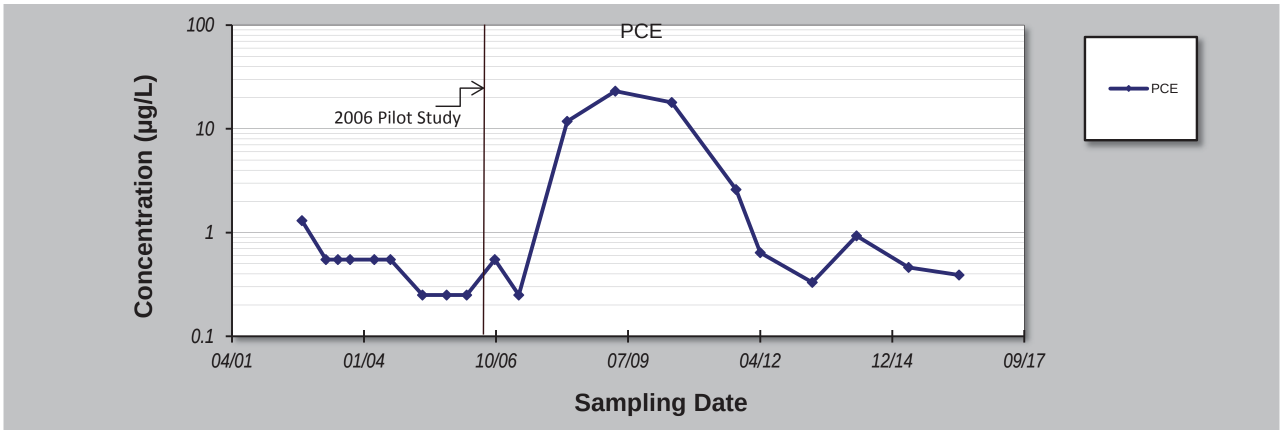
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF02-46C**
Concentration Units: **µg/L**

	Sampling Point ID:	PCE						
Sampling Event	Sampling Date	DCF02-46C CONCENTRATION (µg/L)						
1	10/1/2002	**1.3**						
2	4/1/2003	*0.55*						
3	7/1/2003	*0.55*						
4	10/1/2003	*0.55*						
5	4/1/2004	*0.55*						
6	8/1/2004	*0.55*						
7	4/1/2005	*0.25*						
8	10/1/2005	*0.25*						
9	3/1/2006	*0.25*						
10	10/1/2006	*0.55*						
11	4/1/2007	*0.25*						
12	4/1/2008	**11.8**						
13	4/1/2009	**23.1**						
14	6/1/2010	**18**						
15	10/1/2011	**2.6**						
16	4/1/2012	**0.64**						
17	5/1/2013	**0.33**						
18	4/1/2014	**0.93**						
19	5/1/2015	**0.46**						
20	5/17/2016	**0.39**						
21								
22								
23								
24								
25								
	Coefficient of Variation:	2.04						
	Mann-Kendall Statistic (S):	1						
	Confidence Factor:	50.0%						
	Concentration Trend:	No Trend						



Notes:

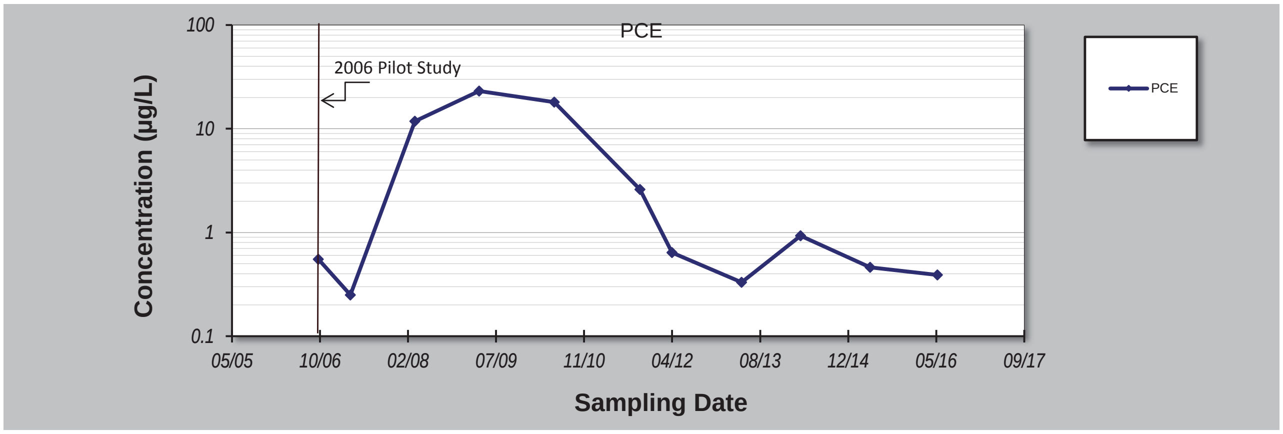
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF02-46C Post 2006 Pilot Studies**
Concentration Units: **µg/L**

Sampling Event	Sampling Date	DCF02-46C POST 2006 PILOT STUDIES CONCENTRATION (µg/L)							
	Sampling Point ID:	**PCE**							
1	10/1/2006	*0.55*							
2	4/1/2007	*0.25*							
3	4/1/2008	**11.8**							
4	4/1/2009	**23.1**							
5	6/1/2010	**18**							
6	10/1/2011	**2.6**							
7	4/1/2012	**0.64**							
8	5/1/2013	**0.33**							
9	4/1/2014	**0.93**							
10	5/1/2015	**0.46**							
11	5/17/2016	**0.39**							
12									
13									
14									
15									
16									
17									
18									
19									
20									
	Coefficient of Variation:	**1.55**							
	Mann-Kendall Statistic (S):	**-13**							
	Confidence Factor:	**82.1%**							
	Concentration Trend:	No Trend							



Notes:

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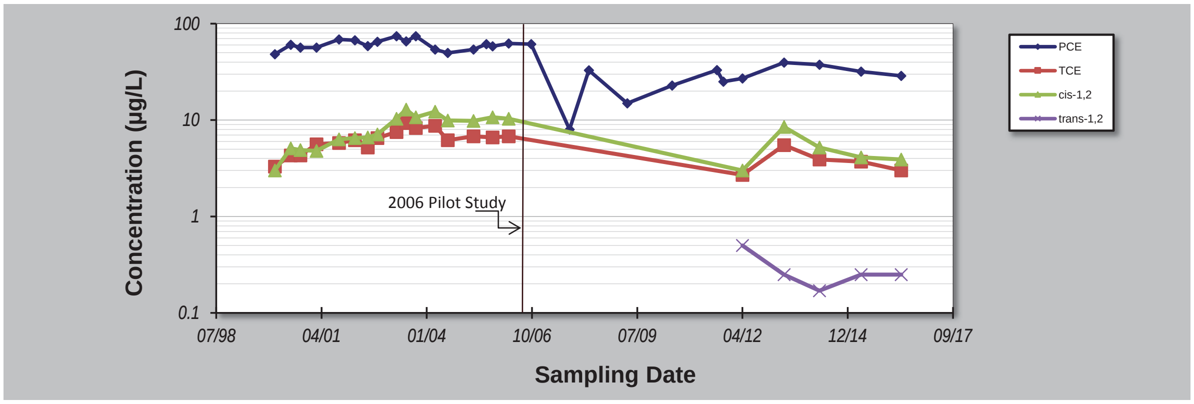
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 6-Jul-16
Facility Name: HydroGeoLogic, Inc.
Conducted By: LV
Job ID: FTRI-027
Constituent: DCF06-25 / DCF96-25
Concentration Units: µg/L

Sampling Point ID:		PCE	TCE	cis-1,2	trans-1,2			
Sampling Event	Sampling Date	DCF06-25 / DCF96-25 CONCENTRATION (µg/L)						
1	2/1/2000	48.3	3.3	3				
2	7/1/2000	60.3	4.3	5.1				
3	10/1/2000	56.4	4.3	4.9				
4	3/1/2001	56.6	5.6	4.8				
5	10/1/2001	68.6	5.8	6.3				
6	3/1/2002	67.2	6.2	6.5				
7	7/1/2002	58.5	5.2	6.6				
8	10/1/2002	64.9	6.5	7.1				
9	4/1/2003	74.2	7.5	10.3				
10	7/1/2003	65.7	9.3	12.9				
11	10/1/2003	74.3	8.3	10.7				
12	4/1/2004	53.9	8.7	12.2				
13	8/1/2004	49.7	6.2	9.9				
14	4/1/2005	54	6.8	9.8				
15	8/1/2005	61.3						
16	10/1/2005	58.3	6.6	10.7				
17	3/1/2006	62.4	6.8	10.3				
18	10/1/2006	61.2						
19	10/1/2007	8.0						
20	4/1/2008	32.8						
21	4/1/2009	14.9						
22	6/1/2010	22.8						
23	8/1/2011	33						
24	10/1/2011	25						
25	4/1/2012	27	2.7	3.0	*0.5*			
26	5/1/2013	39.5	5.5	8.5	0.25			
27	4/1/2014	37.6	3.9	5.2	*0.17*			
28	5/1/2015	31.9	3.7	4.1	*0.25*			
29	5/18/2016	28.8	3	3.9	*0.25*			
30								
Coefficient of Variation:		0.38	0.33	0.42	0.44			
Mann-Kendall Statistic (S):		-164	1	25	-3			
Confidence Factor:		99.9%	50.0%	76.3%	67.5%			
Concentration Trend:		Decreasing	No Trend	No Trend	Stable			



Notes:

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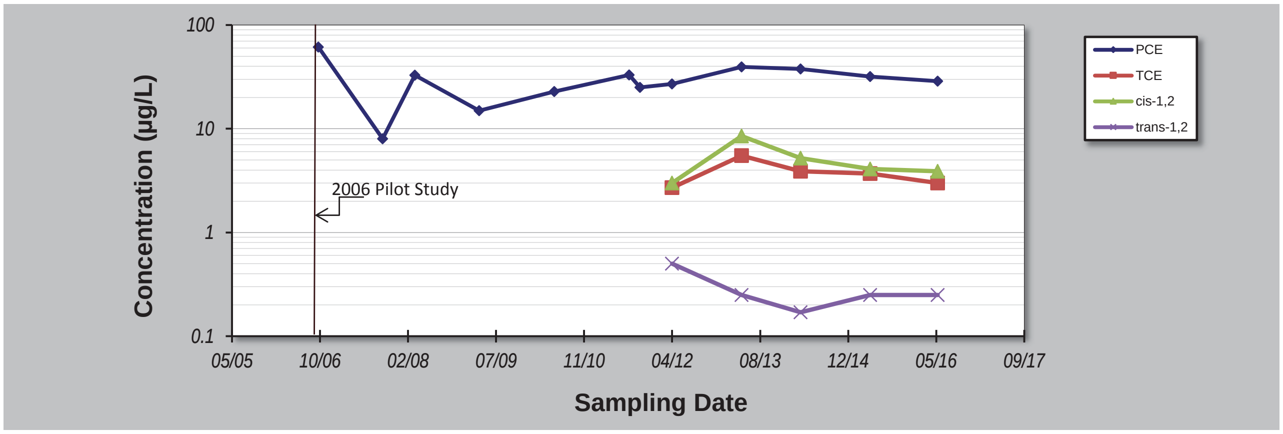
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **6-Jul-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **LV**

Job ID: **FTRI-027**
Constituent: **DCF06-25 / DCF96-25 Post 2006 Pilot Studies**
Concentration Units: **µg/L**

	Sampling Point ID:	**PCE**	**TCE**	**cis-1,2**	**trans-1,2**			
Sampling Event	Sampling Date	DCF06-25 / DCF96-25 POST 2006 PILOT STUDIES CONCENTRATION (µg/L)						
1	10/1/2006	**61.2**						
2	10/1/2007	**8**						
3	4/1/2008	**32.8**						
4	4/1/2009	**14.9**						
5	6/1/2010	**22.8**						
6	8/1/2011	**33**						
7	10/1/2011	**25**						
8	4/1/2012	**27**	**2.7**	**3.0**	*0.5*			
9	5/1/2013	**39.5**	**5.5**	**8.5**	**0.25**			
10	4/1/2014	**37.6**	**3.9**	**5.2**	*0.17*			
11	5/1/2015	**31.9**	**3.7**	**4.1**	*0.25*			
12	5/18/2016	**28.8**	**3**	**3.9**	*0.25*			
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.44	0.29	0.43	0.44			
Mann-Kendall Statistic (S):		12	-2	-2	-3			
Confidence Factor:		77.0%	59.2%	59.2%	67.5%			
Concentration Trend:		No Trend	Stable	Stable	Stable			



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

FINAL
2016 ANNUAL LONG-TERM MONITORING REPORT
DRY CLEANING FACILITIES AREA OPERABLE UNIT 003
(FTRI-027)
FORT RILEY, KANSAS

REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

Prepared for:

U.S. Army Corps of Engineers
Kansas City District

Contract W912DQ-13-D-3000
Task Order 0004

Prepared by:

HydroGeoLogic, Inc.
6340 Glenwood, Suite 200
Building #7
Overland Park, KS 66202

December 2016

HGL
HydroGeoLogic, Inc

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of concern
btoc	below top of casing
COC	chemical of concern
cy	cubic yard
DCE	dichloroethene
DCFA	Dry Cleaning Facilities Area
DO	dissolved oxygen
DPW	Directorate of Public Works
EPA	U.S. Environmental Protection Agency
FTRI	Fort Riley, Kansas
ft	feet or foot
HGL	HydroGeoLogic, Inc.
IC	institutional control
IDW	investigation-derived waste
KDHE	Kansas Department of Health and Environment
LTM	long-term monitoring
LTO	long-term operations
MAROS	Monitoring and Remediation Optimization System
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/L	milligrams per liter
MNA	monitored natural attenuation
mV	millivolts
ORP	oxidation-reduction potential
OU	operable unit
PCE	tetrachloroethene
QC	quality control
QCSR	Quality Control Summary Report
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

RSKs	Risk-Based Standards for Kansas
SWL	static water level
TA2	Training Area 2
TCE	trichloroethene
TO	task order
TOC	total organic carbon
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
VC	vinyl chloride
VOC	volatile organic compound

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1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) is conducting long-term monitoring (LTM) at the Dry Cleaning Facilities Area Operable Unit 003 (OU 003), at Fort Riley (FTRI), Kansas, also referred to as site FTRI-027. This work is being conducted under U.S. Army Corps of Engineers, Northwestern Division, Kansas City District (USACE) contract W912DQ-13-D-3000, task order (TO) 0004, Regional Long-Term Operations (LTO)/LTM. LTM sampling and reporting is being completed as required under the 2008 Record of Decision (ROD), which specified monitored natural attenuation (MNA) and institutional controls (ICs) (USACE, 2008).

HGL's original scope of work for FTRI-027 included annual gauging of 27 LTM wells and annual sampling of 25 of the LTM wells. During the 2015 sampling event, LTM well DCF96-36 could not be located. HGL was informed by the FTRI Directorate of Public Works (DPW) that the well was destroyed by river erosion and will no longer be listed as an LTM well. In addition, optimization recommendations presented in the *2015 Annual Long-Term Monitoring Report* (HGL, 2016a) and approved by USACE eliminated the following six wells from the annual sampling in 2016: DCF02-49C, DCF00-34C, DCF99-37C, DCF99-38C, 354-99-11C, and DCF03-50C. These wells will be sampled in 2017. However, HGL gauged the five wells on the north side of the Kansas River and static water level (SWL) data were used along with the other LTM SWL data collected to create a potentiometric surface map. The wells that were gauged were: DCF02-49C, DCF00-34C, DCF99-37C, DCF99-38C, and 354-99-11C.

This Annual Report presents the results of the annual LTM sampling event conducted in May 2016. HGL conducted the following activities for the May 2016 annual groundwater sampling event:

- Located and inspected the condition of the 25 LTM wells located on the north side of the Kansas River and recorded any deficiencies found;
- Recorded SWL measurements in the 25 LTM wells located on the north side of the Kansas River;
- Collected groundwater samples from 18 of the 26 LTM wells (one of the 19 wells to be sampled had an insufficient amount of water to sample). During sampling the field team measured and recorded field water quality parameters (temperature, pH, specific conductivity, oxidation reduction potential [ORP], dissolved oxygen [DO], and turbidity) to ensure field parameters had stabilized before samples were collected;

- Submitted groundwater samples for analysis of volatile organic compounds (VOCs) and natural attenuation parameters (methane, ethene, ethane, alkalinity, total organic carbon [TOC], nitrate, nitrite, sulfate, sulfide, chloride), along with quality control (QC) samples (field duplicates, matrix spike/matrix spike duplicate, and trip blanks);
- Validated laboratory data and reported the results of data validation in a Quality Control Summary Report (QCSR); and
- Prepared this 2016 Annual Groundwater Monitoring Report to summarize and evaluate the laboratory analytical and hydrogeologic data from the annual groundwater sampling event.

The QCSR for this sampling event was submitted as a separate report (HGL, 2016b). The text and tables from the QCSR are included in Appendix A for completeness. The QCSR discusses laboratory and field quality control, including field completeness, sampling techniques, sampling precision, trip blank results, and any deviations from planned activities.

1.1 SITE DESCRIPTION

The following site description and history is summarized from the ROD (USACE, 2008). FTRI-027 is located in the southwest portion of the Main Post cantonment area in the southern region of Fort Riley, which is located in Geary and Riley Counties, near Junction City, Kansas (Figure 1.1). FTRI-027 is bisected by the Kansas River, which runs through the site from the northwestern edge to the southeastern edge. The site consists of the following five investigation areas (see Figure 1.2):

1) Dry Cleaning Facilities Area (DCFA), original study area consisting of two areas:
    a) Former Buildings 180/181/182 Area
    b) Former Buildings 183/184 Area
2) The Transition Zone,
3) The Island,
4) The Horse Corral, and
5) Training Area 2 (TA2).

The five investigation areas are described in the ROD as follows (USACE, 2008):

The DCFA

The DCFA consists of two areas, the former Buildings 180/181/182 Area and the former Buildings 183/184 Area, where dry cleaning operations were conducted. The DCFA lies atop an alluvial terrace that consists of clays, sands, and silts overlying Permian-age sedimentary rock composed of alternating sequences of shale and limestone. A bedrock erosional channel underlies the eastern portion of former Building 181 site. The axis of the channel runs northeast/southwest, slopes to the southwest, and extends through the Transition Zone into the Island. Sand is present at depth within the bedrock erosional channel.

The Transition Zone

The Transition Zone separates the alluvial terraces beneath the DCFA from the river alluvial deposits that underlie the Island and the Horse Corral. The Transition Zone is where the geology "transitions" from the upper terrace system beneath the DCFA to the point bars of the alluvial system beneath the Island and the Horse Corral. The Transition Zone is composed of Kansas River alluvium interspersed with colluvial deposits from the upland and terrace areas. Soil in the Transition Zone is composed primarily of alluvial sediment deposited by the Kansas River. The subsurface lithology within the Transition Zone consists of an upward-fining sequence of medium to coarse sand with traces of gravel present above the bedrock. The deposits fine upward into a fine sand with an upper layer of silty clay/clayey silt present in places. The Union Pacific Railroad (UPRR) tracks lie within the Transition Zone.

The Island

The Island consists of a point bar formed by the Kansas River. This area is located between the DCFA and the Kansas River. The Island consists of approximately 40 heavily-wooded acres that are undeveloped and currently serve as a winter roosting area for bald eagles. The Island is underlain by Kansas River alluvium, composed of river sediments and erosional deposits from the upland and terrace areas. Subsurface lithologies in this area represent an upward-fining sequence typical of alluvial point bar and floodplain sediments.

The Horse Corral

The Horse Corral is the western portion of a point bar located downstream of the Island, and is located southeast of OU 003. This area is located immediately west and adjacent to the 354 Area Solvent Detections site (OU 005). The Horse Corral is bounded by Henry Drive to the east, the Kansas River to the west and south, and the UPRR tracks to the north. The point bar is currently used for pasturing and training Fort Riley's horses. The Horse Corral is underlain by Kansas River alluvium is composed of river sediments and erosional deposits from the upland and terrace area. Subsurface lithologies in this area represents an upward-fining sequence typical of alluvial point bar and floodplain sediments.

TA2

TA2 consists of the Kansas River floodplain located along the south side of the Kansas River directly across from the Island. TA2 is heavily wooded and is used by FTRI for military exercises. It is undeveloped and is also a winter roosting area for bald eagles. TA2 is underlain by Kansas River alluvium is composed of Kansas river sediments and erosional deposits from the upland and terrace area. Subsurface lithologies in this area represents an upward-fining sequence typical of alluvial point bar and floodplain sediments.

1.2 SITE HISTORY

Buildings 180/181 were the location of the original dry cleaning (1930 to 1983) and laundry operations (1915 to 1983) before these operations were transferred to Building 183. The former Building 180/181 Area is located south of Custer Road. Building 182 was a storage building. Stoddard solvent, a petroleum distillate mixture, was used as the dry cleaning solution from 1944 until 1966. From 1966 until dry cleaning operation ceased in 1983, tetrachloroethene (PCE) was used as the cleaning solution. Buildings 180/181 and 182, and the surrounding parking lots and sidewalks were demolished in the summer of 2000. Building 183 housed laundry facilities from 1941 to 2002 and included dry cleaning facilities from 1983 to 2002. A steam generation plant was present at Building 184. Buildings 183 and 184 were located north of Custer

Road. Buildings 183 and 184, and most surrounding structures, were demolished in the fall 2002. The locations where Buildings 180/181, 182, 183, and 184 once stood are now empty grassy lots.

Environmental investigations and sampling events performed at Fort Riley in the 1970s and 1980s identified activities and facilities where hazardous substances had been released or had the potential to be released into the environment. Site investigation field activities at the DCFA began in October 1991. In addition, several pilot studies involving the injection of sodium permanganate solution, potassium permanganate, and/or CAP 18™ (a proprietary unsaturated vegetable oil-based product that provides a long-term carbon source for anaerobic bioremediation) were conducted at the following site areas of concern (AOCs) (see Figure 1.2) from November 2005 through September 2006:

- AOC 1 - soil source removal area in the DCFA.
- AOC 2 - groundwater injection area in the vicinity of AOC 1.
- AOC 3 - vadose and saturated zone injection site near wells DCF02-42 and DCF06-25.
- “Other Areas” (previous report reference) - groundwater injection areas in the vicinity of:
    - DCF02-49C (referred also to as the Pilot Study Area on the Island in this report).
    - DCF99-37C (referred also to as the Pilot Study Area Northwest of the Horse Corral in this report).
    - 354-99-11C (referred also to as the Pilot Study Area Northeast of the Horse Corral in this report).

In February 2010, an additional groundwater injection pilot study was conducted at AOC 2.

The following table is a brief summary of site activities conducted.

1992	Preliminary Assessment was conducted, including monitoring well installation. PCE, trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride (VC) detected in soil and groundwater at DCFA.
1994	Remedial Investigation (RI) conducted to identify the types, quantities, and distribution of contaminants.
1994/1995	Soil vapor extraction contaminant removal action and pilot study conducted.
1995	Feasibility Study prepared and submitted.
1998	RI approved by the Kansas Department of Health and Environment (KDHE) after completion of additional sampling.
2000	U.S. Environmental Protection Agency (EPA) conducted a review of removal actions conducted in 1994 and 1995.
	FTRI conducted additional source screening.
2002	Additional groundwater investigations conducted. Soil sampling conducted after demolition of Buildings 183 and 184.
2004	Addendum to RI prepared summarizing additional soil and groundwater investigations conducted in 2002, submitted, and approved.
2005 to 2007	AOC 1 and AOC 2: Pilot study for soil and groundwater remediation conducted, involving the treatment and removal of 2,400 cubic yards (cy) of soil, the injections of 3,692 gallons of 10 percent sodium permanganate solution and 8,200 pounds of

	CAP18™. AOC 3: Pilot study involving vadose zone injection of approximately 7,400 pounds of sodium permanganate aqueous solution. Other Areas: Pilot study involving injection of 5,530 pounds of CAP18™.
2008	ROD approved with selected remedy of MNA and ICs.
	Remedial Design/Remedial Action Plan submitted.
2008 and 2009	Annual groundwater monitoring conducted as part of MNA.
2010	AOC 1 and AOC 2: Treatment of groundwater with 2,500 pounds of CAP18™.
2011 to present	Annual groundwater monitoring conducted as part of MNA.
2012	Five-Year Review indicates biodegradation is contributing to decrease in PCE concentrations.

1.3 PURPOSE AND SCOPE

The baseline human health and ecological risk assessments completed for FTRI-027 found that the estimated risks to human health and the environment were within or below the EPA acceptable levels. Therefore, no chemicals of concern (COCs) were identified in the ROD. However, because groundwater at FTRI-027 is considered to have a potential beneficial use as a drinking water source due to its hydraulic connection to the Kansas River, drinking water standards have been considered relevant and appropriate as cleanup levels. According to the ROD, clean-up levels are defined as the EPA maximum contaminant levels (MCLs).

The selected remedy for remediation of groundwater contamination at FTRI-027 was MNA and ICs. MNA relies on natural degradation processes occurring at the site to further reduce contaminant concentrations to levels below the MCLs. MNA groundwater sampling has been conducted at FTRI-027 since approval of the ROD, from 2008 through 2016. This report presents the results of the 2016 annual groundwater sampling event, which included sampling wells in the DCFA, Transition Zone, and the Island, but did not include sampling the wells in the Pilot Study Areas on the Island and the Horse Corral, or TA2.

ICs identified in the ROD include:

- Restricting use to non-residential
- Limiting public access
- Prohibiting installation of drinking water wells and groundwater use in the area
- Involving Directorate of Public Works - Environmental Division personnel in proposed future plans for the DCFA Site

Restrictions are to be enforced through the Installation Real Property Master Plan.

2.0 GROUNDWATER SAMPLING, RESULTS AND ANALYSIS

This section summarizes the fieldwork conducted during the May 2016 annual groundwater sampling event, the groundwater sample analytical results, a comparison of the analytical results to risk-based levels, and the results of the statistical analysis performed.

2.1 STATIC WATER LEVELS

SWLs were measured in monitoring wells located on the north side of Kansas River on May 16, 2016, except in well DCF93-08. A SWL could not be measured in well DCF93-08 because the water level was below the top of the pump. When attempting to sample this well on May 18, 2016, the field team removed the pump from the well and measured a SWL of 41.8 feet (ft) below top of casing (btoc).

An electronic water-level meter was used to measure SWL below the top of the well casings to the nearest 0.01 ft. Table 2.1 presents SWL data collected during the May 2016 sampling event along with SWLs from the previous four sampling events. Figure 2.1 presents the potentiometric surface generated from the May 2016 SWL measurements. Based on the water level elevations, the groundwater flow at the site is generally southwest toward the Kansas River. This is consistent with historical data.

2.2 GROUNDWATER SAMPLING AND ANALYSIS

The 2016 groundwater sampling event at FTRI-027 was conducted May 16, 17, and 18. Eighteen of the nineteen wells planned to be sampled were sampled during the field event. The following is a list of deviations from the *Site-Specific Work Plan*:

- Per approved recommendations in the *2015 Annual Long-Term Monitoring Report* (HGL, 2016a) the following wells were not sampled in 2016: DCF02-49C, DCF00-34C, DCF99-37C, DCF99-38C, 354-99-11C, and DCF03-50C.
- Well DCF93-08 could not be sampled because there was an insufficient amount of water in the well.
- It was discovered during the field event that there are two wells in the vicinity of the DCF06-25 well location. Some historical maps show a well labeled DCF06-25 in the area and other maps show a well labelled DCF96-25 in the same location. One well is approximately ¾-inch in diameter (this is the well that was sampled in 2015). The second well, located about 50 feet east of the first well in a more densely wooded area, is a 2-inch diameter well and has a dedicated pump. Per discussions with FTRI DPW after discovering the wells, the 2-inch well was sampled using the dedicated pump. It is believed that the ¾-inch well is DCF96-25, which FTRI DPW thought had been abandoned.

The monitoring well locations are shown on Figure 1.2. Groundwater sampling was performed using low-flow purging protocol in accordance with the Site-Specific Work Plan (HGL, 2014). Groundwater samples were collected using dedicated QED SamplePro bladder pumps at 17 of the wells. Groundwater samples were collected from monitoring well DCF96-27 using a peristaltic pump, because the inside well diameter was approximately one inch. Because all but one of the wells had a dedicated pump, cross contamination of the wells from using a non-dedicated pump during sampling was not a concern. Thus, the wells were not sampled in a specific order (i.e., wells with the lowest concentrations first).

A YSI 556 meter with a flow-through cell was used for measuring the following stabilization parameters during well purging: temperature, pH, specific conductivity, ORP, and DO. A Hanna meter was used to measure turbidity. Groundwater samples were collected when the stabilization parameters were observed within the stated range for three consecutive readings monitored at 5-minute intervals. In addition to the stabilization parameters measured prior to sampling, a ferrous iron reading was collected using a Hach test kit. Results of the field readings for the 2016 sampling event were recorded on field sampling forms included in Appendix B.

All groundwater samples and QC samples collected were shipped to Accutest Laboratories, Inc. in Orlando, Florida for analysis. The LTM wells were sampled for laboratory analysis of VOCs and the following MNA parameters: methane, ethene, ethane, alkalinity, TOC, nitrate, nitrite, sulfate, sulfite, and chloride. HSW Engineering in Tampa, Florida, conducted the data validation, which is included in the QCSR (HGL, 2016b).

Liquid investigation-derived waste (IDW) generated during sampling activities was containerized, labeled and stored until analytical results were received and evaluated. The IDW was then disposed of by Solvent Recovery, LLC. Disposable materials such as latex gloves, used PPE, paper towels, and similar items, were placed and sealed in plastic garbage bags for disposal with sanitary waste from the site.

2.3 ANALYTICAL RESULTS

A summary of the laboratory analyses results are presented in Table 2.2 along with a comparison to MCLs (EPA, 2016) and KDHE Risk-Based Standards for Kansas (RSKs) (KDHE, 2010) for residential groundwater (KDHE, 2010). Table 2.2 also includes the results of the MNA parameter analyses. MNA parameter results are discussed further in Section 2.5.

The only contaminants detected above their respective MCLs were PCE, cis-1,2-DCE, and VC.

PCE was detected above the MCL of 5 micrograms per liter (μg/L) at the following well locations:

- DCF02-42 (5.5 μg/L)
- DCF02-44A (12.4 μg/L)
- DCF02-44C (18.5 μg/L)
- DCF02-47C (6.2 μg/L)
- DCF02-48C (11.0 μg/L)
- DCF06-25 (28.8 μg/L)

VC and cis-1,2-DCE were detected in only one well at concentrations above their MCLs of 2 μg/L and 70 μg/L, respectively: DCF93-13 at 7.5 μg/L (VC) and 73.4 μg/L (cis-1,2-DCE).

Tables 2.3 and 2.4 present a summary of the available historical analytical laboratory results for the AOC 1 and AOC 2 Pilot Study Area and the AOC 3 Pilot Study Area, respectively. Figures 2.2 through 2.5 present the April 2009, April 2012, May 2015, and May 2016 groundwater results for PCE and associated daughter products TCE, cis-1,2-DCE, and VC. The April 2009 data are representative of the site after the 2006 pilot studies and prior to the 2010 Pilot Study. The April 2012, May 2015, and May 2016 datasets show concentration levels at 2, 5, and 6 years after the 2010 Pilot Study, respectively.

The map of PCE concentrations for 2016 (Figure 2.2) shows one general area of contamination above the MCL of 5 μg/L. The area encompasses the AOC 3 Pilot Study Area and the DCF02-44, DCF02-47, and DCF02-48 well locations to the southeast along the Kansas River. The PCE plumes have fluctuated over the monitoring time period.

Figure 2.3 presents the TCE concentration data. Following the 2006 pilot studies all TCE concentrations have been below the MCL.

The map of cis-1,2-DCE concentrations (Figure 2.4) shows one area of contamination above the MCL of 70 μg/L. The plume is centered around well DCF93-13, located in the AOC 1 and AOC 2 Pilot Study Area. This is the first time the concentration of cis-1,2-DCE has exceeded the MCL at this location.

The map of VC concentrations (Figure 2.5) shows one area of contamination above the MCL of 2.0 μg/L. The plume is centered around well DCF93-13 located within the AOC 1 and AOC 2 Pilot Study Area. The concentrations of VC have increased since the 2006 pilot studies.

2.4 STATISTICAL ANALYSIS

The Mann-Kendall trend analysis was conducted on available PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and VC data to identify potential trends in contaminant concentrations at FTRI-027. Analysis was performed using the GSI Mann-Kendall Toolkit (GSI, 2012).

2.4.1 Statistical Analysis Data

Data from Tables 2.3 and 2.4 were used for trend analysis. The data were divided into two datasets for the trend analyses. One dataset included all available historical data from February 2000 to present (see Appendix C) and the second dataset included all available data obtained after the 2006 pilot studies (post 2006).

Trend analyses were evaluated for well locations with at least four sampling events and two detections of at least one of the contaminants of concern. Before running the trend analysis on the data presented in Tables 2.3 through 2.5, “U” coded and “ND” data (data where there were no detections above the method detection limit) were converted to values representing half the presented detection limit. If no detection limit was available, the value of 0.25 μg/L was used, because the majority of nondetects in the dataset with detection limits were 0.50 U. The Mann-Kendall Trend graphs for the full dataset and post-2006 dataset are included in Appendix D.

2.4.2 Results of Statistical Analysis

The results of the Mann-Kendall trend analyses are summarized in the following tables:

Pilot Study Area	Full Dataset	Post-2006 Pilot Study Dataset
AOC 1 and AOC 2	Table 2.5	Table 2.6
AOC 3	Table 2.7	Table 2.8

Statistical analyses were run on the full available dataset to present an overall picture of the contaminant trends. However, the following discussions focus on the results of post-2006 dataset trend analyses. Focusing on the smaller, more recent, dataset is intended to give a better indication as to the contaminant trends based on the site conditions produced by the introduction of chemicals to enhance biodegradation within the most contaminated zones.

AOC 1 and AOC 2 Pilot Study Area

Treatment Area Wells

The treatment area wells in the AOC 1 and AOC 2 Pilot Study Area include DCF92-05, DCF93-13, and DCF06-40. The contaminant trend analysis indicates that two of the wells (DCF93-13 and DCF06-40) have decreasing PCE trends and at one well (DCF92-05) there is no trend in PCE concentrations (Table 2.6). PCE contaminant levels have been at or below the MCL of 5 μg/L at well DCF92-05 since the May 2013 sampling event and well DCF93-13 since the January 2007. The PCE concentrations at DCF06-40, which were consistently above the MCL from October 2001 through August 2011, have since fluctuated above and below the MCL and was below the MCL during the May 2016 sampling event with a detection of 3.8 μg/L.

TCE concentration trends are showing stable trends at all three treatment area wells (Table 2.6). TCE results, based on available results, have been below the MCL of 5 μg/L since the October 2006 sampling event. The October 2006 sampling event was the first sampling event following the 2006 Pilot Study.

Concentration trends for cis-1,2-DCE are no trend at wells DCF92-05 and DCF06-40. The concentration trend at DCF93-13 is increasing, with the May 2016 result above the MCL of 70 μg/L.

In addition to the increasing cis-1,2-DCE trend at DCF93-13, trans-1,2-DCE and VC concentrations are also increasing according to the Mann-Kendall analyses in DCF93-13. These trends are consistent with the degradation of PCE. The current concentration levels of trans-1,2-DCE are well below the MCL of 100 μg/L. However, the levels of VC at well DCF93-13 have been detected above the MCL of 2 μg/L since the April 2009 sampling event.

Side-Gradient Wells

The side-gradient wells in the AOC 1 and AOC 2 Pilot Study Area include DCF93-19, DCF93-20, DCF93-08, and DCF96-27. Available data indicates that well DCF93-08 has had insufficient water to sample during the 2012 through 2016 sampling events and no statistical analysis was conducted for this well. Of note in the remaining wells is the increasing PCE concentration trend at well DCF93-20 located to the east of the treatment area. Though PCE was first detected at the well following the 2006 Pilot Study, the PCE concentrations have not been detected above the MCL.

Down-Gradient Wells

The down-gradient wells in the AOC 1 and AOC 2 Pilot Study Area include DCF02-41, DCF02-44A, DCF02-44C, DCF02-47C, DCF02-48A and DCF02-48C. PCE concentrations in the down-gradient wells are showing stable concentration trends, with wells DCF02-44A, DCF02-44C, DCF02-47C, and DCF02-48C currently having PCE concentrations above the MCL. Wells DCF02-41 and DCF02-48A have decreasing TCE concentration trends. In addition, TCE levels in the wells have not exceeded the MCL since the 2006 Pilot Study. Of note is the decreasing cis-1,2-DCE concentrations at well DCF02-41 located just south of the UPRR tracks. The cis-1,2-DCE concentrations have been above the MCL of 70 μg/L from the August 2004 sampling event through the April 2014 sampling event, but were below the MCL during the May 2015 and May 2016 sampling events.

AOC 3 Pilot Study Area

Treatment Area Wells

Two monitoring wells exist in the AOC 3 Pilot Study Area: DCF02-42 and DCF06-25. The Mann-Kendall analysis indicates that the PCE concentrations are stable or show no trend, however, the concentrations are above the MCL of 5 μg/L. The TCE concentrations are stable, and are currently below the MCL of 5 μg/L.

Down-Gradient Wells

The down-gradient wells in the AOC 3 Pilot Study Area include DCF02-46A and DCF02-46C. The PCE concentrations in the two down-gradient wells are currently showing no trend in the data and PCE concentration levels have not been above the MCL since October 2011. The TCE concentration trend at well DCF02-46A is stable, and TCE concentration levels have not been above the MCL over the history of the well (2002 through 2016).

2.5 NATURAL ATTENUATION PARAMETERS

The following parameters were analyzed during the May 2016 sampling event to help evaluate the conditions present for natural attenuation:

Laboratory Analysis	Field Measurements
Methane	Temperature
Ethane	pH
Ethene	DO
Alkalinity, Total as $CaCO_3$	ORP
Chloride	Ferrous Iron
Nitrogen, Nitrite	
Nitrogen, Nitrate	
Sulfate	
Sulfide	
TOC	

The results of the laboratory analyses are presented in Tables 2.2 and 2.9. The field measurements were collected as part of the pre-sampling well purging stabilization process. Data recorded were documented on the field forms provided in Appendix B and is summarized in Table 2.9. The laboratory and field data were compared to the Analytical Parameters and Weighting for Preliminary Screening for Anaerobic Biodegradation Processes table in the *Technical Protocol for the Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998). Table 2.9 presents a summary of the comparison.

The following parameters were evaluated and the noted parameters were reported in ranges considered favorable for reductive dechlorination of chlorinated VOCs in the 18 wells sampled:

- Temperature was recorded below the favorable level of 20° C in all the wells.
- pH was reported between 5.0 and 9.0 in all samples. pH readings in this range are considered to be favorable for reductive dechlorination.
- DO was reported at levels less than 0.5 milligrams per liter (mg/L), the level considered to be tolerable, in 1 of the wells.
- ORP was reported to be less than 50 millivolts (mV) in 8 of the 18 monitoring wells sampled. ORP results less than 50 mV are considered to have a possible reductive dechlorination pathway, and those with an ORP less than -100 mV are likely to have a reductive dechlorination pathway. No results were recorded less than -100 mV.
- Ferrous Iron was reported to be $>$ 1 mg/L, the level considered favorable, in 5 of the wells.
- Methane concentrations greater than 500 μg/L are considered favorable for reductive dechlorination. Methane in this range was detected in 1 of 18 monitoring wells sampled.
- Alkalinity was detected in one well at a level greater than 2 times the background.
- Nitrate as N was reported at $<$ 1 mg/L, the level considered favorable, in 7 wells.
- TCE, a daughter product of PCE, was detected in 12 wells.
- cis-1,2-DCE, a daughter product of TCE, was detected in 12 wells.
- VC, a daughter product of cis-1,2-DCE and trans-1,2-DCE, was detected in 4 wells.

2.6 PILOT STUDY PERFORMANCE REVIEW

This section provides a review of the analytical and field sampling results for the May 2016 groundwater sampling event performed to monitor the performance of the Pilot Study remediation efforts completed in each AOC at FTRI-27.

AOC 1 and AOC 2

The AOC 1 soil source removal included removal of approximately 2,400 cy of soil for treatment at an on-post treatment cell, removal of soil from around abandoned sewer lines and manholes, and injection of oxidant for in-situ cleanup. During the oxidant injection 3,692 gallons of 10 percent sodium permanganate solution was injected along the sewer lines, at associated manholes, and in the vicinity of the abandoned high-pressure gas line trench to remediate the remaining chlorinated VOCs. This work was performed in November and December 2005.

The AOC 2 groundwater CAP18™ injection pilot study was performed in the same vicinity as the AOC 1 soil source removal to enhance the degradation of the chlorinated VOCs in this area

(Figure 1.2). In April of 2006, approximately 8,200 pounds of CAP18™ was injected though 72 injection points in the bedrock erosional channel in the area surrounding monitoring wells DCF06-40 DCF92-03, and DCF93-13. CAP18™ is an unsaturated vegetable oil-based product that provides a long-term carbon source for anaerobic bioremediation. In February of 2010, CAP18™ was injected into the deepest portion of the bedrock erosional channel to further enhance the degradation of chlorinated VOCs in the area. Approximately 2,500 pounds of CAP18™ was injected though 10 injection points along the axis of the bedrock erosional channel in the area surrounding monitoring wells DCF06-40, DCF93-03 and DCF93-13.

The May 2016 groundwater sample results and historical groundwater sample results are presented in Table 2.3 and are arranged to show monitoring wells in the AOC 1 and AOC 2 treatment area, and wells down gradient and side gradient to the groundwater flow direction. The dates of the CAP18™ injections are also presented to provide a reference for when the pilot studies were performed.

Treatment Area Wells

As shown on Table 2.3, PCE and TCE contaminant concentrations have decreased below the MCL. In addition, the PCE and TCE concentrations, following the 2006 Pilot Study, are showing decreasing and stable trends, respectively. The cis-1,2-DCE, trans-1,2-DCE and VC results at DCF93-13 are all showing increasing trends, which is an indication that reductive dechlorination of PCE is occurring in the treatment area.

Side-Gradient Wells

No VOCs were detected above the MCLs in the side-gradient monitoring wells following the 2010 Pilot Study, with the exception of a TCE detection in May 2013 at well DCF93-20.

Down-Gradient Wells

PCE concentrations are above the MCL of 5 μg/L at DCF02-44A, DCF02-44C, DCF02-47C, and DCF02-48C and trend analysis indicates the concentrations are currently stable. No other contaminants in the downgradient wells are currently above the MCLs.

Summary

The treatment of PCE contamination in the most contaminated zone of AOC 1 and AOC 2 with sodium permanganate solution and CAP18™ appears to have effectively enhanced the reductive dechlorination of PCE in the treatment zone. However, the presence of VC is now a concern because it is above the MCL and VC generally requires aerobic conditions to naturally degrade. VC does not currently appear to be migrating, as it has not been detected in the down-gradient monitoring wells.

The presence of PCE above the MCL at down-gradient wells DCF02-44A, DCF02-44C, DCF02-47C, and DCF02-48C should continue to be monitored.

AOC 3

The AOC 3 Pilot Study conducted in January and February 2006 involved vadose zone injection of approximately 7,400 pounds of sodium permanganate solution at 23 locations near monitoring well DCF02-42 to reduce the potential for groundwater contamination near monitoring wells

DCF02-42 and DCF96-25. In April 2006, approximately 21,755 pounds of potassium permanganate was injected into the saturated zone between monitoring wells DCF02- 42 and DCF96-25 to destroy groundwater contaminants through oxidation.

The May 2016 groundwater sample results and historical groundwater sample results are presented in Table 2.4 and are arranged to show monitoring wells in the AOC 3 treatment area and wells down gradient with respect to the groundwater flow direction. The dates of the sodium permanganate and potassium permanganate injections are also presented to provide a reference for when the Pilot Study remediation efforts were performed.

Treatment Area Wells
Though the overall PCE and TCE concentration trends, based on available data from 2000, generally indicate that PCE and TCE are decreasing, the post pilot study data indicates concentrations are stable or have no trend. In addition, PCE concentrations in the treatment zone are above the MCL.

Down-Gradient Wells
All VOCs in AOC 3 down-gradient wells are currently below MCLs.

Summary
The treatment of PCE contamination in the most contaminated zone of AOC 3 with sodium permanganate solution and a separate potassium permanganate solution injection appears to have had a limited effect on the reductive dechlorination of PCE in the treatment zone.

The treatment area and down-gradient wells should continue to be monitored.

2.7 WELL INSPECTION AND MAINTENANCE

The wells were inspected during the May 2016 sampling event and noted conditions were recorded on the Well Maintenance Form included in Appendix B. As noted on the Well Maintenance Forms, the majority of the wells needed to be painted and the vegetation cleared from around the well areas. This work was completed in October and November 2016. Well maintenance photos are included in Appendix B.

2.8 OPTIMIZATION

The groundwater sampling plan recommended in the Remedial Design/Remedial Action (RD/RA) Plan (Burns & McDonnell, 2008), developed after the 2006 pilot studies, was three annual sampling events in 2008, 2009, and 2010 followed by Five-Year Review sampling if necessary. After three years of sampling, an additional pilot study was conducted in 2010, with follow-up sampling in 2011 and then Five-Year Review sampling in 2012. Additional annual sampling was then scheduled through 2016, with a mandate that the sampling protocol be evaluated during the 2017 Five-Year Review (as per March 19, 2013, Department of the Army letter to the EPA, Region 7).

The RD/RA Plan states "if no Island alluvial wells exceed groundwater clean-up levels (MCLs) for the COC at the end of the three years of sampling (2008, 2009, 2010) or during 5-year review sampling, a recommendation for discontinuing sampling and site close out will be made as part of the five-year review. Otherwise sampling will continue as discussed in the RD/RA Plan." Five wells (DCF02-44A, DCF02-44C, DCF02-47C, DCF02-48C, and DCF06-25) located in the area defined as the Island had detections of COCs above the MCLs. In addition, HGL evaluated whether the Monitoring and Remediation Optimization System (MAROS) software could be run on the site data to determine potential optimization strategies. However, in order to run some of the statistical analyses that are part of the MAROS software, six years of data collection is required. For the majority of the LTM wells and COCs there is currently only five years of data that were collected over a consistent time frame since the 2010 pilot study was completed. Therefore, at this time, HGL recommends that groundwater sampling continue at AOC 1 and AOC 2 and AOC 3. However, HGL recommends that the three wells associated with the Pilot Study Area Northwest of the Horse Corral and the Pilot Study Area Northeast of the Horse Corral (DCF99-37C, DCF99-38C, 354-99-11C) no longer be sampled. No contaminants have been detected above MCLs at these wells for nine years.

3.0 SUMMARY AND RECOMMENDATIONS

This section summarizes the field and analytical data for the May 2016 groundwater sampling event and the results of the statistical analyses conducted on available site data.

3.1 GROUNDWATER FLOW

Based on the water level elevation data collected during the May 2016 sampling event, the groundwater flow at the site is generally southwest toward the Kansas River (Figure 2.1). This is consistent with historical data.

3.2 ANALYTICAL RESULTS

The only contaminants detected above their respective MCLs during the May 2016 sampling event were PCE, cis-1,2-DCE, and VC. PCE was detected above the MCL of 5 μg/L at the following well locations:

- DCF02-42 (5.5 µg/L)
- DCF02-44A (12.4 µg/L)
- DCF02-44C (18.5 µg/L)
- DCF02-47C (6.2 µg/L)
- DCF02-48C (11.0 µg/L)
- DCF06-25 (28.8 µg/L)

VC and cis-1,2-DCE were detected in only one well at concentrations above their MCLs of 2 µg/L and 70 µg/L, respectively: DCF93-13 at 7.5 µg/L (VC) and 73.4 µg/L (cis-1,2-DCE).

3.3 STATISTICAL ANALYSIS

The Mann-Kendall analysis of available Post 2006 Pilot Study data for PCE and TCE indicates, for a majority of the wells, a decreasing, stable, or no trend. Increasing contaminant concentration trends were observed in the data at the following well locations:

Well	COC	Location
DCF93-13	cis-1,2-DCE	AOC 1 and AOC 2 treatment area
	trans-1,2-DCE	
	VC	
DCF93-20	PCE	AOC 1 and AOC 2 side gradient
DCF02-41	trans-1,2-DCE	AOC 1 and AOC 2 down gradient of treatment area

The increasing trend in PCE at well DCF93-20 may be an indication that PCE had migrated from the potential source area. However, the concentrations are below the MCL of 5 μg/L and PCE in the source area has been effectively reduced to levels below the MCL, indicating that the PCE concentration trend at DCF93-20 is likely to reverse with time.

The increasing trends in concentrations of cis-1,2-DCE, trans-1,2-DCE and VC at DCF93-13 are expected in an area where there is reductive dechlorination of PCE occurring. However, the levels of VC at well DCF93-13 in the AOC 1 and AOC 2 Pilot Study Area have been detected above the MCL of 2 μg/L since the April 2009 sampling event.

3.4 PILOT STUDY PERFORMANCE

AOC 1 and AOC 2 Pilot Study Area

The treatment of PCE contamination with sodium permanganate solution and CAP18™ appears to have effectively reduced PCE concentrations in the treatment zone. However, the presence of VC in well DCF93-13 may now be a concern, as VC generally requires aerobic conditions to naturally degrade. The VC does not currently appear to be migrating, though, as it has not been detected in the down-gradient monitoring wells.

The presence of PCE above the MCL at down-gradient wells DCF02-44A, DCF02-44C, DCF02-47C, and DCF02-48 should continue to be monitored.

AOC 3

The treatment of PCE contamination at AOC 3 with sodium permanganate solution and a separate potassium permanganate solution injection appears to have had a limited effect on the reduction of PCE contamination in the treatment zone.

The treatment area and down-gradient wells should continue to be monitored.

3.5 WELL MAINTENANCE

The monitoring well inspection conducted during the May 2016 sampling event indicates the wells are in generally good condition but require painting, and vegetation needs to be cleared.

3.6 OPTIMIZATION RECOMMENDATIONS

HGL recommends that annual groundwater sampling continue at the 19 wells associated with AOC 1 and AOC 2 and AOC 3. In addition, the following wells should also be sampled in 2017 in association with the five-year review: DCF02-49C, DCF00-34C, and DCF03-50C.

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354-99-11C Before Maintenance

354-99-11C Completed Maintenance

DCF00-34C Before Maintenance

DCF00-34C Completed Maintenance

DCF02-41 Before Maintenance

DCF02-41 Completed Maintenance

DCF02-42 Before maintenance

DCF02-42 Completed maintenance

DCF02-43 Before Maintenance

DCF02-43 Completed Maintenance

DCF02-44 A_front C_back Before Maintenance

DCF02-44 A_front C_back Completed Maintenance

DCF02-46 A_front C_back Before Maintenance

DCF02-46 A_front C_back Completed Maintenance

DCF02-47 A_front C_back Before Maintenance

DCF02-47 A_front C_back Completed Maintenance

DCF02-48 A_back C_front Before Maintenance

DCF02-48 A_back C_front Completed Maintenance

DCF02-49C Before Maintenance

DCF02-49C Completed Maintenance

DCF06-25 Before Maintenance

DCF06-25 Completed Maintenance

DCF06-40 Before maintenance

DCF06-40 Completed maintenance

DCF92-01 Before maintenance

DCF92-01 Completed maintenance

DCF92-05 Before maintenance

DCF92-05 Completed maintenance

DCF93-08 Before maintenance

DCF93-08 Completed maintenance

DCF93-13 Before maintenance

DCF93-13 Completed maintenance

DCF93-19 Before maintenance

DCF93-19 Completed maintenance

DCF93-20 Before Maintenance

DCF93-20 Completed Maintenance

DCF96-25 Before Maintenance

DCF96-25 Completed Maintenance

DCF96-27 Before Maintenance

DCF96-27 Completed Maintenance

DCF99-37C Before Maintenance

DCF99-37C Completed Maintenance

DCF99-38C Before Maintenance

DCF99-38C Completed Maintenance

APPENDIX H

354 AREA SOLVENT DETECTIONS

OU 005

BACKGROUND INFORMATION

- PRE-DESIGN INVESTIGATION REPORT, 2017 (PART)
- ANALYTICAL TABLES
- STATISTICAL ANALYSIS
- VISL WORKSHEETS
- 2016 ANNUAL SITE INSPECTION

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PRE-DESIGN INVESTIGATION REPORT

354 AREA - OPERABLE UNIT 005
FORT RILEY, KANSAS

Final

June 2017

Prepared for:

U.S. Army Corps of Engineers – Kansas City District

Prepared by:

AVATAR
ENVIRONMENTAL

BURNS
McDONNELL

Contract No. W912DQ-12-D-3003
Task Order 0006

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Acronyms/Abbreviations

354	354 Area Operable Unit 005 site
ALS	ALS Environmental
Avatar	Avatar Environmental, LLC
ASR	Annual Sampling Report
AVS	Acid Volatile Sulfides
BAI	bioavailable ferric iron
bgs	below ground surface
CENWK	USACE – Kansas City District
°C	degrees Celsius
cis-1,2 DCE	cis-1,2 Dichloroethene
COC	Contaminants of Concern
DO	dissolved oxygen
ESD	Explanation of Significant Difference
ft	feet
GC	gas chromatograph
HGL	HydroGeoLogic, Inc.
ICs	institutional controls
IDW	investigative-derived waste
IRP	Installation Restoration Program
KDHE	Kansas Department of Health and Environment
MCL	maximum contaminant level
MEE	methane, ethane, and ethene
mg/L	milligrams per liter
MNA	monitored natural attenuation
MP	microbial presence
MS	matrix spike
MSD	matrix spike duplicate
mS/cm	millisiemens per centimeter
mV	millivolt
NTU	Nephelometric Turbidity Unit
ORP	oxidation-reduction potential
PAL	project action limit
PCE	Tetrachloroethene
PDI	Pre-Design Investigation
PID	photoionization detector
PWE	Public Works – Environmental Division
QCSR	Quality Control Summary Report
ROD	Record of Decision
RSK	Risk-Based Standards for Kansas
RSL	Regional Screening Levels
TCE	Trichloroethene
THQ	target hazard quotient
TOC	total organic carbon
trans-1,2 DCE	trans-1,2 dichloroethene

TR	Target Risk
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VFA	volatile fatty acids
VOC	volatile organic compound
µg/kg	micrograms per kilogram
µg/L	micrograms per liter

1. INTRODUCTION

1.1 PURPOSE AND SCOPE

The Fort Riley Directorate of Public Works – Environmental Division (PWE) is performing the Installation Restoration Program (IRP) at Fort Riley, Kansas. This program is designed to identify and address potential threats to human health and the environment. 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 numerous sites on the post to support the IRP effort.

CENWK has contracted Avatar Environmental, LLC (Avatar) to prepare work plan documents, execute the field work, prepare quality control summary reports (QCSRs), prepare annual sampling reports (ASRs) and a pre-design investigation (PDI) report for the 354 Area Operable Unit 005 site (354).

The primary source of tetrachloroethene (PCE) was an area directly east and adjacent to Building 367, located approximately 1,200 feet north of Building 354 on Carr Avenue. The area was subject to a pilot study in 2004 and 2005 to remove a “hotspot” of contamination in the soil. The soil was treated by mechanically mixing potassium permanganate with the soil. The process did not remediate the PCE below the target cleanup goal of 180 micrograms per kilogram (μg/kg) (BMcD, 2005).

A Record of Decision (ROD) was completed for the site in 2006 (BMcD, 2006). The Contaminants of Concern (COC’s) and cleanup levels for groundwater listed in the ROD are:

- PCE Maximum Contaminant Level (MCL) of 5 micrograms per liter (μg/L)
- Trichloroethene (TCE) MCL of 5 μg/L
- cis-1,2-Dichloroethene (cis-1,2-DCE) MCL of 70 μg/L
- Benzene MCL of 5 μg/L

The remedy selected in the ROD was Monitored Natural Attenuation (MNA) with institutional controls (ICs). Monitoring wells were sampled semiannually from 2001 through 2004 and annually from 2005 through 2009. Additional sampling events were completed in August 2011, April 2012, March 2014, and July 2014. The March and July 2014 data indicated that PCE concentrations in monitoring wells 354-99-09, 354-01-27, and TSO292-01 were no longer steadily decreasing and had increased to 2006 levels (BMcD, 2006). The values obtained in the 2016 May and August sampling events show PCE concentrations in exceedance of the 5 µg/L MCL. The concentrations detected at the three previously mentioned monitoring wells are; 12 µg/L and 5.3 µg/L at 354-99-09, 85 µg/L and 5.5 µg/L at 354-01-27 and 39 µg/L and 20 µg/L at TSO292-01.

An Explanation of Significant Difference (ESD) was developed in February 2015 (Directorate of Public Works, 2015). The ESD states that active remediation is required to address the levels of PCE in the three terrace material monitoring wells identified as 354-01-27, 354-99-09, and TSO292-01. Based on the data from the March and July 2014 sampling events it was determined that continuing with the MNA remedy as stated in the ROD would result in ineffective PCE treatment of terrace groundwater that could eventually impact down-gradient Kansas River alluvial groundwater. A more detailed description of previous remedial activities at the 354 Area can be found in the project-specific work plan (Avatar, 2016c).

The purpose of the 354 Area PDI is to determine if there are any persistent sources of residual PCE contamination present in vadose zone soils near the former source area that may be contributing to increasing groundwater contaminant levels, further refine the nature and extent of PCE contamination in soil and groundwater, monitor the groundwater concentrations in existing monitoring wells, confirm that alluvial wells have not been impacted by PCE in upgradient terrace material, and perform associated reporting requirements.

This PDI report presents the results of the direct-push field investigation performed at the site in April and May 2016 as well as groundwater sampling events 1 and 2. The analytical results for soil and groundwater samples collected are presented herein. A recommendation is made regarding future work that may be performed at the site. QCSRs have been prepared that provide summaries of the validation results for analytical data from the off-site laboratory (Avatar, 2016a and 2016b).

A project-specific work plan was prepared for this project (Avatar, 2016c). A summary of all installation-wide work plan documents and project specific work plan documents was included in Section 1.0 of the project specific work plan.

The technical approach for the 354 Area project involved the following steps:

- Collection of direct-push soil samples to determine if any residual PCE contamination is present in vadose zone soils in the source area (Building 367) that may be contributing to increasing groundwater contaminant levels present at the 354 Area;
- Collection of direct-push soil samples to refine the nature and extent of PCE contamination in vadose zone soils near the source area (Building 367);
- Collection of direct-push groundwater samples to delineate the nature and extent of contamination in groundwater at the source area (Building 367);
- Collection of direct-push groundwater samples to delineate the nature and extent of contamination in groundwater down-gradient of the source area (Building 367);
- Collection of groundwater samples from existing monitoring wells;
- Collection of in-situ geochemical data from soil and groundwater to determine the most viable in-situ remedial technologies, and if bioaugmentation will be necessary.

1.2 SITE DESCRIPTION

Figure 1-1 depicts the location of Fort Riley, which is located in Geary, Riley and Clay Counties, Kansas. The more developed areas of Fort Riley are located in the southern portion of the reservation adjacent to the Republican and Kansas Rivers. The 354 site is located on Main Post, just north of the Kansas River (Figure 1-1). The 354 site currently encompasses portions of the Main Post as far north as Godfrey Avenue, and virtually the entire point bar south of the Union Pacific Railroad (UPRR) grade and east of the Henry Drive bridge. The former building 354 was constructed in 1935 as a gasoline service station. In addition to gasoline and diesel fuel, it may have been subsequently used as a storage site for solvents and road oil. Building 354 was not confirmed as a source of PCE contamination. The primary source of PCE was Building 367, located approximately 1200 feet up gradient of Building 354 on Carr Avenue. This building is within the overall 354 site and was constructed in 1903. Figure 1-2 shows site details including direct-push boring locations, monitoring wells, and the location of Building 367.

2. PHYSICAL SETTING AND SITE HISTORY

2.1 LOCATION AND PHYSICAL SETTING

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

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 (less than 1 degree) to the west-northwest and consists of alternating beds of limestone and shale of the Permian Chase and Council Grove Groups. The Barneston 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 feet (ft). The bedrock surface has been eroded by the major rivers and streams. The major streams tend to flow to the east and south due to topography. The rivers are broad, shallow, and slow-moving. Karst features have not been identified within the limestone formations at Fort Riley.

In the major river valleys, alluvial sand, silt, and gravel deposits reach a thickness of approximately one hundred feet 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.

The effects of bedrock geology on the extent of contamination was discussed in detail in the Remedial Investigation Report for 354 Area Solvent Detections at Main Post Fort Riley, Kansas (BMcD, 2003). Groundwater is unconfined in the terrace deposits (terrace aquifer). Groundwater within the terrace aquifer is present directly above the bedrock surface, with a saturated thickness ranging from zero (dry) to about 16 ft. The bedrock surface has been eroded by the major rivers and streams. On the terrace, the bedrock topography was sculpted by tributary streams, which flowed into the ancestral Kansas River at roughly right angles to the direction of river flow. Groundwater flow in the terrace aquifer is controlled by the topography of the bedrock surface, which imparts a southerly direction of groundwater flow. The additional data collected during the PDI supports the conclusions of the RI that groundwater flow is controlled by the surface topography of the bedrock surface. Figure 2-1 illustrates the extent of PCE contamination. In the terrace aquifer, the PCE plume is bound by low level detections, non-detections and borings with no measurable water on the western edge and non-detections and borings with no measurable water on the eastern edges. The plume becomes channelized in the transition zone before entering the Kansas River alluvial aquifer. In the Kansas River alluvial aquifer, the PCE plume is bound by a line of non-detections along the southern edge. No protected or special ecological or cultural features were observed or are known to occur at or near this site. The site area is gently sloping, mix between developed and undeveloped land. A site map showing the location of the 354 site at Fort Riley is provided in Figure 1-1.

2.2 SITE HISTORY

Building 367 was constructed in 1903 and originally served as an artillery gun shed. The building has subsequently been used as a vehicle maintenance shop and for storage. The one-story building encompasses 15,024 square feet and is constructed of limestone block on a limestone foundation. Building 367 is on the National Register of Historic Places as a member of the Cavalry and Artillery thematic group within Main Post Historic District. The parking lot around Building 367 and the ground floor of the building are both paved concrete.

3. FIELD ACTIVITIES

3.1 SUMMARY OF PDI FIELD ACTIVITIES

Field activities at the 354 Area site included the sampling of soil and groundwater using direct-push sampling equipment, groundwater sampling using low flow protocols at seven on-site monitoring wells, and the management of investigative-derived waste (IDW). Prior to commencing field activities, underground utilities were marked out by Fort Riley Digsafe and Kansas One Call. Figure 1-2 shows the site details including boring locations and monitoring well locations. The following subsections of this report detail the investigation activities. A copy of the field logbook and boring logs are included in Appendix A; copies of the Daily Quality Control Reports are in Appendix B; and survey data is in Appendix C.

A total of 79 borings were advanced in the vicinity and down-gradient of Building 367 (Figure 3-1 and Figure 3-2) between April 11, 2016 and May 25, 2016, using direct-push sampling equipment for the collection of groundwater and soil samples. Samples were collected using standard quality control procedures and safety measures, a detailed description of procedures can be found in the work plan (Avatar, 2016c). At 10 direct-push boring locations, both soil and groundwater samples were collected. Direct-push soil borings were advanced to either 20 or 50 feet (ft) below ground surface (bgs). One soil sample was collected from each five-foot interval based on PID field screening measurements or visual signs of contamination which is further detailed in the work plan (Avatar, 2016c). Upon completion of soil sampling and borehole logging, the direct-push borings were advanced to bedrock refusal to collect groundwater samples from each location. At seven of ten boring locations, the direct-push soil borings were advanced to 50 ft bgs. At the remaining three boring locations, the direct-push soil borings were advanced to 20 ft bgs. During soil boring advancement, the site geologist prepared a lithologic log for each boring. Cross section lines are shown on the Figure 3-3 and Figures 3-4 and 3-5 illustrate north-south and west-east geologic cross sections across the site.

The remaining 69 direct-push boring locations were advanced to bedrock refusal to collect groundwater samples. As illustrated in Figure 1-2, 57 borings were advanced in the terrace aquifer, 7 borings were advanced in the transition zone, and 15 borings were advanced in the Kansas River alluvial aquifer. Groundwater samples were collected using an inertial lift pump and high-density polyethylene tubing from within a drop screen. Two groundwater samples were collected from direct-push locations that had a measured saturated thickness greater than 10 ft. One groundwater sample was collected from direct-push locations that had a measured saturated thickness less than 10 ft. A single groundwater sample was collected from 59 direct-push locations and were submitted to be analyzed on the on-site field laboratory gas chromatograph (GC) for TCE, PCE, and cis-1,2-DCE. Two groundwater samples were collected from 14 direct-push locations and submitted to the on-site field GC for analysis of TCE, PCE, and cis-1,2 DCE. There were six direct-push boring locations which were advanced to bedrock refusal and groundwater was not encountered (see section 2.1 for geology description); therefore, no samples were collected.

Confirmation soil and groundwater samples were shipped for off-site laboratory analysis at a rate of approximately 10 percent of the total samples collected. Two duplicate soil samples, three duplicate groundwater samples, one soil matrix spike (MS)/matrix spike duplicate (MSD) sample, and two groundwater MS/MSD samples were collected in accordance with the project work plan and shipped for off-site laboratory analysis. Two soil and four groundwater equipment rinsate blanks were also collected. Soil samples were shipped to ALS Environmental in Houston, TX (ALS), Test America in Pittsburgh, PA and Prima Environmental in El Dorado Hills, CA. Groundwater samples were shipped to ALS. Soil samples were submitted to the laboratories each day and groundwater samples were submitted to the laboratory twice a week. Trip blanks were placed in all coolers that contained volatile organic compounds (VOCs) or methane, ethane, and ethene (MEE) samples. Appendix D includes copies of the chain-of-custody forms for analytical samples.

At 11 of the direct-push boring locations, not all samples described in the work plan were collected for the following reasons:

- At DP-02 the sample interval from 45 to 50 ft bgs was not sampled because the soil was saturated throughout the interval indicating the presence of groundwater.
- At DP-04 and DP-05 soil or groundwater samples were not collected due to issues accessing and moving equipment stored in the storage bays in building 367.

- At DP-06 the sample interval was changed from one foot to two feet due to the need to use dual-tube samplers because of limited overhead space.

- At DP-39, DP-40, DP-61, DP-66, DP-77, and DP-78 groundwater was not encountered; therefore, no samples were collected. At DP-10 the total depth was changed from 20 ft bgs to 40 ft bgs due to high photoionization detector (PID) field screening readings. The field team was exercising due diligence to determine whether or not elevated PID readings were indicative of VOC contamination. Field GC results for samples collected from 20 to 40 ft bgs did not show any exceedances for VOCs.

These deviations in sample collection can be attributed to sampling plans and PID screening for sample intervals as detailed in the beginning of this section. All direct-push boring locations were surveyed by a Kansas registered land surveyor following sample collection. Survey data is provided in Appendix C.

3.2 SUMMARY OF GROUNDWATER MONITORING FIELD ACTIVITIES

Groundwater monitoring activities are ongoing at the 354 Area site to determine whether additional remedial actions are necessary and the effectiveness of potential remedial actions. Eight groundwater sampling events will be completed quarterly for two years through 2018. Avatar completed the first and second of the eight quarterly groundwater sampling events in May and August 2016. The results from the first and second events are discussed in further detail below. HydroGeoLogic, Inc. (HGL) also completed a groundwater sampling event in July 2016 as part of a separate contract. In that event, groundwater samples were collected from four wells including 354-01-27, 354-99-09, TSO292-01, and TSO292-02. Data on the sampling event can be found in Appendix E-1.

Seven monitoring wells at the 354 Area site (354-01-27, 354-99-09, TS0292-01, TS0292-02, 354-99-12C, 354-99-13C, 354-01-30C) comprise the groundwater monitoring well network for the quarterly monitoring events. Monitoring wells 354-01-27, 354-99-09, and TS0292-01 are located in the terrace aquifer, and monitoring well TS0292-02 is located in the transition zone between the terrace and Kansas River alluvial aquifers, as shown in Figure 3-1 and 3-2. Monitoring wells 354-

99-12C, 354-99-13C, and354-01-30C are located in the Kansas River alluvial aquifer and have not been sampled since 2009.

Groundwater sampling activities included measuring groundwater elevation, low flow sampling from 354 Area site monitoring wells, and the management of IDW. A summary of groundwater elevations from the first and second events are presented in Table 4-1. Refer to Figure 3-1 for the monitoring well locations and May 2016 groundwater contours and Figure 3-2 for the August 2016 groundwater contours. The Groundwater Sampling Forms are included in Appendix A and Daily Quality Control Reports are in Appendix B.

One duplicate sample and one MS/MSD sample was collected in accordance with the project work plan. Samples were submitted to the laboratory at the end of the day and trip blanks were placed in all coolers which contained VOC or MEE samples. Appendix D includes copies of the chain of custody forms for analytical samples.

The site geologist prepared a Groundwater Sample Form for each monitoring well (see Appendix A). Groundwater samples were collected using a dedicated bladder pump and high-density polyethylene tubing. Groundwater samples were collected from the center of the saturated screen length. More detailed information regarding sampling methodology is provided in the work plan (Avatar, 2016c).

Groundwater samples were submitted to ALS located in Houston, TX, Katahdin Laboratory located in Scarborough, ME, and Microbial Analyses Laboratory located in Knoxville, TN. Included in the analyses are VOCs which are known as the site contaminants, as well as other parameters that provide a better understanding of the viability of the subsurface setting for biodegradation. These analyses are shown below:

- VOCs
- MEE
- Alkalinity
- Anions (chloride, nitrite, nitrate, sulfate)
- Sulfide
- Total Organic Carbon (TOC)
- Dissolved Manganese
- Dissolved Iron

- Volatile Fatty Acids (VFAs) (first sampling event only.)
- Microbial Presence (MP) (first sampling event only.)

The following field measurements were collected for each groundwater sample. Associated methods and techniques for sampling and analyses can be found within the work plan (Avatar, 2016c).

- Temperature
- pH
- Specific conductance
- Oxidation-reduction potential (ORP)
- Dissolved oxygen (DO)
- Turbidity
- Ferrous iron

3.3 INVESTIGATION DERIVED WASTE

Soil cuttings, purge water and decontamination water generated during the field investigation and the first quarterly groundwater sampling event were containerized in labeled 55-gallon drums and staged outside Building 367 pending the return of analytical results. Following an evaluation of these results, CENWK and Fort Riley PWE approved the spreading of the cuttings on the ground surface in a grassy area south of the railroad tracks. Liquid IDW from the 354 Area site was discharged to the sewer. Concrete and asphalt cores were disposed of at the Campbell Hill construction and debris landfill. Empty IDW drums were transported to the recycle center at Camp Funston for disposal. This IDW disposal work was completed on August 19, 2016. Purge water from the second quarterly sampling event was discharged to the sewer upon completion of field activities. These disposal methods were detailed and approved within the IDW Management Plan (BMcD, 2003).

4. NATURE AND EXTENT OF CONTAMINATION

4.1 NATURE AND EXTENT OF SOIL CONTAMINATION

As previously discussed in Section 3, soil collection intervals were determined by PID screening. Soil samples were initially screened for PCE, TCE, and cis-1,2 DCE using a mobile field GC. Approximately 10% of samples were submitted for off-site laboratory confirmation analyses. These samples were chosen based on on-site GC results. In addition to being analyzed for VOCs, samples shipped off-site were analyzed for acid volatile sulfides (AVS), bioavailable ferric iron (BAI), manganese (Mn), TOC, and percent moisture. Lab reports for AVS and BAI are located in Appendix E-2. VOCs were detected in soil samples collected from the direct-push borings advanced at the site in both on-site and off-site analysis. On-site laboratory analyses were limited due to time constraints however, samples submitted to the off-site laboratory were analyzed for a full suite of analytes (Avatar, 2016 c). VOCs detected by the field GC included PCE, TCE, and cis-1,2 DCE and are presented in Table 4-2 (detections only). Soil sample results from the off-site laboratory are presented in Table 4-3 (detections only). VOCs detected by the off-site laboratory included PCE, TCE, and cis-1,2 DCE. No other VOCs were detected. Results from the manganese, TOC, and percent moisture analyses are included on Table 4-3. Results for AVS and BAI are included on Table 4-4. A comparison of field GC and off-site laboratory results can be found in Table 4-5.

None of the soil samples had detections that exceeded project action limits (PALs). PALs presented on Table 4-2 and 4-3 (detections only) were established based on a hierarchy starting with Kansas Department of Health and Environment (KDHE) non-residential soil Risk-Based Standards for Kansas (RSKs) (KDHE, 2015), followed by United States Environmental Protection Agency (USEPA) Industrial Soil Regional Screening Levels (RSLs) based on values as provided in the QAPP. There are no RSKs or RSLs for AVS, BAI, TOC, and percent moisture; therefore, no PAL was established for these analytes. Soil samples were collected from each 5 ft interval at 10 of the direct-push boring locations. Soil samples were not collected at direct-push borings DP-04 and DP-05 due to access issues.

A detailed discussion for each of the analytes detected by the field GC in soil follows:

- PCE was detected in soil samples collected from one or more intervals from all direct-push borings from which soil samples were collected. PCE concentrations ranged from 6.0 estimated value (J) µg/kg (Boring DP-02) to 260 µg/kg (Boring DP-07) (see Table 4-2). None of the soil samples collected at any of the direct-push borings exceeded the PAL of 210,000 µg/kg for PCE. Figure 4-1 shows PCE concentrations in soil across the site.

- TCE was detected in soil samples collected from one or more intervals in two of the ten direct-push borings from which soil samples were collected. TCE concentrations ranged from 14.3 µg/kg (Boring DP-10) to 33.9 µg/kg (Boring DP-07) (see Table 4-2). None of the soil sample concentrations detected exceeded the PAL of 9,910 µg/kg for TCE. Figure 4-1 shows TCE concentrations in soil across the site.

- cis-1,2 DCE was detected in soil samples collected from one or more intervals in nine of the ten direct-push borings from which soil samples were collected. Concentrations of cis-1,2 DCE ranged from 4.6 J µg/kg (Boring DP-02) to 50.1 µg/kg (Boring DP-07) (see Table 4-2). None of the soil sample concentrations detected exceeded the PAL of 38,700 µg/kg for cis-1,2 DCE. Figure 4-1 shows cis-1,2 DCE concentrations in soil across the site.

A detailed discussion for each of the analytes detected by the off-site laboratory in soil follows:

- PCE was detected in six of the eleven soil samples collected and shipped for off-site laboratory analysis. PCE concentrations ranged from 2.4 J µg/kg (Boring DP-08) to 74 µg/kg (Boring DP-03) (see Table 4-3). None of the soil samples collected at any of the direct-push borings exceeded the PAL of 210,000 µg/kg for PCE. Figure 4-1 shows PCE concentrations in soil across the site.

- TCE was detected in three of eleven soil samples collected and shipped for off-site laboratory analysis. TCE concentrations ranged from 1.9 J µg/kg (Boring DP-10) to 9.5 J µg/kg (Boring DP-07) (see Table 4-3). None of the soil sample concentrations detected exceeded the PAL of 9,910 µg/kg for TCE. Figure 4-1 shows TCE concentrations in soil across the site.

- cis-1,2 DCE was detected in three of eleven soil samples collected and shipped for off-site laboratory analysis. Concentrations of cis-1,2 DCE ranged from 2.9 J µg/kg (Boring DP-03) to 21 J µg/kg (Boring DP-07) (see Table 4-3). None of the soil sample concentrations detected exceeded the PAL of 38,700 µg/kg for cis-1,2 DCE. Figure 4-1 shows cis-1,2 DCE concentrations in soil across the site.

- Manganese was detected in all samples collected and shipped for off-site laboratory analysis. Manganese concentrations ranged from 22.1 mg/kg (Boring DP-11) to 413 mg/kg (Boring DP-08) (see Table 4-3). None of the soil sample concentrations detected exceeded the PAL of 22,067 mg/kg for manganese.

- BAI was detected in all samples collected and shipped for off-site laboratory analysis. BAI concentrations ranged from 0.83 g/kg (Borings DP-03 and DP-07) to 4.2 g/kg (Boring DP-08) (see Table 4-4). Bioavailable iron is a measure of ferric iron in soil that can be converted to ferrous iron by iron-reducing bacteria.

- AVS was not detected in any samples collected and shipped for off-site laboratory analysis (see Table 4-4). AVS is the reactive solid-phase sulfide fraction, and appears to affect the bioavailability of most divalent metal ions as the sulfide ions have a high affinity for divalent metals. Metals in the solid metal sulfide form are thus considered non-bioavailable, and are unlikely to cause toxicity in sediment-dwelling organisms

A comparison of on-site field GC and off-site laboratory (ALS) results is shown in Table 4-5. The results were compared using linear regression techniques. Due to variations in dilutions and the reporting limits between the on-site field GC and ALS, only VOC detections were evaluated for the overall linear regression calculations. Non-detected results were not included in the evaluation. Linear regression analyses were performed for the soil data sets, and the results are summarized in Table 5 of the QCSR for the 354 Area PDI and Groundwater Monitoring Event 1 (Avatar, 2016a). A copy of the QCSR is in Appendix E-1.

For the soil data set, the correlation coefficient between the on-site GC and off-site confirmation results was 0.13 which did not meet the minimum regression criteria of 0.70 established in the

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) (Avatar, 2016d). Since the soil sample results were spread over an order of magnitude, the data were also log-transformed and evaluated using linear regression yielding a correlation coefficient of 0.44, which did not meet the minimum criteria of 0.70 specified in the QAPP (Avatar, 2016a).

However, the on-site soil VOC data are not planned to be used for soil delineation or risk assessment studies. As such, they are deemed to be acceptable for the purpose they were intended, which is determining the presence or absence of a secondary source in the vadose zone adjacent to Building 367. Results were determined to be acceptable based on the following criteria:

- All detections by the on-site field GC were confirmed at lower concentrations by the off-site laboratory.
- In samples where VOC constituents were non-detect by the field GC these constituents were also confirmed to be non-detect or below the reporting limit by the off-site laboratory (see below).
    - PCE - non-detect for three samples by the on-site field GC, also confirmed to be non-detect or below the reporting limit by the off-site laboratory.
    - TCE - non-detect for nine samples by the on-site field GC also confirmed to be non-detect or below the reporting limit by the off-site laboratory.
    - Cis-1-2 DCE - non-detect for five samples by the on-site field GC also confirmed to be non-detect or below the reporting limit by the off-site laboratory.
- All detections of VOC constituents (both field GC and off-site laboratory) were well below their respective screening levels by more than two orders of magnitude.
    - PCE – the screening value was 210,000 µg/kg while the highest values detected by the on-site field GC was 312 µg/kg, and off-site laboratory was 74 µg/kg.
    - TCE – the screening value was 9,910 µg/kg while the highest value detected by the on-site field GC was 33.9 µg/kg and by the off-site laboratory was 9.5 J µg/Kg.

- cis-1-2 DCE – the screening value was 22,067 µg/kg while the highest value detected by the on-site field GC was 50.1 µg/kg and by the off-site laboratory was 21 J µg/kg.

4.2 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

4.2.1 Direct-Push Groundwater Borings

As previously discussed in Section 3, groundwater samples were submitted to be analyzed on the on-site field laboratory GC for PCE, TCE, and cis-1,2 DCE with a mobile field GC, and from these samples approximately 10% were submitted for off-site laboratory analysis. Samples shipped off-site were analyzed for a wider list of VOCs and also for MEE. VOCs were detected in groundwater samples collected from the direct-push borings advanced at the site in both on-site and off-site analysis. MEE was detected in all samples shipped for off-site analysis. Groundwater sample results from the field GC are presented in Table 4-6 (detections only). VOCs detected by the field GC included PCE, TCE, and cis-1,2 DCE. Field parameters were also collected from groundwater samples. The field parameters include pH, temperature, DO, ORP, specific conductivity and ferrous iron (Fe). A summary of field parameters collected from groundwater samples is presented in Table 4-7. Groundwater sample results from the off-site laboratory are presented in Table 4-8 (detections only). VOCs detected by the off-site laboratory included acetone, benzene, chloroform, cis-1,2 DCE, ethylbenzene, naphthalene, PCE, toluene, trans-1,2 dichloroethene (trans-1,2 DCE), and TCE. Due to time constraints, on-site laboratory analyses were limited, however samples sent to the off-site laboratory were analyzed for a full suite of contaminants. Although not all analytes were sampled on- and off-site, a comparison of field GC and off-site laboratory results of analytes sampled in both locations can be found in Table 4-9.

PALs presented on Table 4-8 and 4-10 were established based on a hierarchy starting with Kansas Department of Health and Environment (KDHE) non-residential RSK (KDHE, 2015), followed by EPA MCL and then the secondary MCL. Groundwater samples exceeded PALs in the case of benzene, cis-1,2 DCE, naphthalene, PCE, and TCE. Groundwater samples were collected from directly above bedrock at each of the direct-push boring locations. Groundwater samples were not collected at direct-push borings DP-04 and DP-05 due to access issues or from DP-39, 40, 61, 66, 77, and 78 since no groundwater was encountered.

A detailed discussion for each of the analytes detected by the field GC in groundwater follows:

- PCE was detected in groundwater samples collected from 53 of 79 total direct-push borings. PCE concentrations ranged from 3.0 µg/L (Boring DP-67) to 80.6 µg/L (Boring DP-21) (see Table 4-6). Thirty-two of the groundwater samples collected at the direct-push borings exceeded the PAL of 5 µg/L for PCE. Figure 2-1 shows the spatial distribution of PCE results in groundwater across the site.

- TCE was detected in groundwater samples collected from six of 79 total direct-push borings. TCE concentrations ranged from 3.1 µg/L (Boring DP-38) to 10.4 µg/L (Boring DP-21) (see Table 4-6). Four of the groundwater sample concentrations detected exceeded the PAL of 5 µg/L for TCE.

- cis-1,2 DCE was detected in groundwater samples collected from 14 of 79 total direct-push borings. Concentrations of cis-1,2 DCE ranged from 1.8 J µg/L (Boring DP-80) to 47.1 µg/L (Boring DP-21) (see Table 4-6). None of the groundwater sample concentrations detected exceeded the PAL of 70 µg/L for cis-1,2 DCE.

The following natural attenuation indicator parameters were measured in groundwater samples from all direct-push boring locations:

- pH
- Temperature
- DO
- ORP
- Specific Conductivity
- Ferrous iron

By measuring these natural attenuation indicator parameters, it is possible to document and qualitatively evaluate possible biodegradation occurring at the site and develop potential remedial alternatives. See Table 4-7 for natural attenuation parameter results.

- **pH:** pH values range from 6.18 to 7.70. Typically, a pH between 5.0 and 9.0 is considered optimal for microbial activity. pH values across the site are within the ideal range for microbial activity.

- **Temperature:** Temperature values ranged from 12.49 degrees Celsius (°C) to 24.54 °C. Groundwater temperature directly influences the metabolic activity of microorganisms in groundwater. Temperatures above 20 °C are favorable for biodegradation. Of the samples collected, 26% were above 20 °C while 54% were less than the favorable temperature for biodegradation.

- **DO:** DO values range from 0.11 to 3.81 milligrams per liter (mg/L). DO values greater than 0.5 mg/L but less than 5 mg/L are considered ideal for aerobic activity. Roughly 30% of samples exceeded the 0.5 mg/L value allowing for ideal aerobic conditions, whereas 61.25% were below 0.5 mg/L. A total of 16.25% of samples were greater than 0.5 mg/L but less than 5 mg/L and 61.25% were outside the range of 0.5 to 5 mg/L.

- **ORP:** ORP values range from -179.2 millivolt (mV) to 49.7 mV. ORP is an indicator of electron activity in the groundwater. High ORP readings are typically associated with oxidizing conditions, while low ORP readings are associated with reducing conditions.

- **Specific Conductivity:** Specific conductivity values ranged from 0.180 millisiemens per centimeter (mS/cm) to 4.250 mS/cm. Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the number of dissolved solids (such as salt) in the water.

- **Ferrous Iron:** Ferrous iron values were not obtained due to high turbidity interference with the turbidity meter. Ferric Iron (Fe^{3+}) is used as a terminal electron acceptor during anaerobic biodegradation of organic carbon. During this process, ferric iron is reduced to ferrous iron (Fe^{2}+), which may be soluble in water.

A detailed discussion for each of the analytes detected by the off-site laboratory in groundwater follows. Figure 4-2 shows analytical results in groundwater across the site for groundwater samples collected by direct-push.

- Acetone was detected in two of eleven samples that were collected and shipped for off-site laboratory analysis. Acetone concentrations were 3.4 µg/L (Boring DP-29) and 14 J µg/L

(Boring DP-41) (see Table 4-8). None of the groundwater sample concentrations exceeded the PAL of 45,500 µg/L for acetone. Acetone is a common laboratory contaminant.

- Benzene was detected in three of eleven samples that were collected and shipped for off-site laboratory analysis. Benzene concentrations ranged from 0.21 J µg/L (Boring DP-42) to 5.2 J µg/L (Boring DP-41) (see Table 4-8). One groundwater sample (Boring DP-41) exceeded the PAL of 5 µg/L for benzene. Benzene contamination is believed to originate from the former Building 354. The former Building 354 was constructed as a gasoline service station with two 100,00-gallon USTs, one 12,800-gallon UST, and one 8,500-gallon UST. DP-41 and DP-42 are both located down-gradient of the former Building 354.

- Chloroform was detected in five of eleven samples that were collected and shipped for off-site laboratory analysis. Chloroform concentrations ranged from 1.3 J µg/L (Boring DP-07) to 2.1 µg/L (Boring DP-19) (see Table 4-8). None of the groundwater sample concentrations exceeded the PAL of 80 µg/L for chloroform.

- cis-1,2 DCE was detected in eight of eleven samples that were collected and shipped for off-site laboratory analysis. Concentrations of cis-1,2 DCE ranged from 0.64 J µg/L (Boring DP-42) to 78 µg/L (Boring DP-21) (see Table 4-8). One groundwater sample (Boring DP-21) exceeded the PAL of 70 µg/L for cis-1,2 DCE.

- Ethylbenzene was detected in four of eleven samples that were collected and shipped for off-site laboratory analysis. Ethylbenzene concentrations ranged from 0.33 J µg/L (Boring DP-67) to 10 J µg/L (Boring DP-41) (see Table 4-8). None of the groundwater sample concentrations exceeded the PAL of 700 µg/L for ethylbenzene.

- Naphthalene was detected in two of eleven samples that were collected and shipped for off-site laboratory analysis. Naphthalene concentrations were 1.7 µg/L (Boring DP-42) and 18 J µg/L (Boring DP-41) (see Table 4-8). One groundwater sample (Boring DP-41) exceeded the PAL of 2.11 µg/L for naphthalene. Naphthalene contamination is believed to originate from the former Building 354. The former Building 354 was constructed as a gasoline service station with two 100,00-gallon USTs, one 12,800-gallon UST, and one

8,500-gallon UST. DP-41 and DP-42 are both located down-gradient of the former Building 354.

- PCE was detected in seven of eleven samples that were collected and shipped for off-site laboratory analysis. PCE concentrations ranged from 0.42 J µg/L (Boring DP-82) to 170 µg/L (Boring DP-21) (see Table 4-8). Four of the groundwater samples (Borings DP-18, 21, 11, and 42) exceeded the PAL of 5 µg/L for PCE.

- Toluene was detected in seven of eleven samples that were collected and shipped for off-site laboratory analysis. Toluene concentrations ranged from 0.26 J µg/L (Boring DP-82) to 0.77 J µg/L (Boring DP-18) (see Table 4-8). None of the groundwater sample concentrations exceeded the PAL of 1,000 µg/L for toluene.

- trans-1,2 DCE was detected in one sample that was collected and shipped for off-site laboratory analysis. The trans-1,2 DCE concentration was 1 µg/L (Boring DP-21) (see Table 4-8). This groundwater sample did not exceed the PAL of 100 µg/L for trans-1,2 DCE.

- TCE was detected in seven of eleven samples that were collected and shipped for off-site laboratory analysis. TCE concentrations ranged from 0.46 J µg/L (Boring DP-18) to 16 µg/L (Boring DP-21) (see Table 4-8). One groundwater sample (Boring DP-21) exceeded the PAL of 5 µg/L for TCE.

A comparison of on-site field GC and off-site laboratory (ALS) results is shown in Table 4-9. The results were compared utilizing linear regression techniques. Due to variations in dilutions and the reporting limits between the on-site field GC and ALS, only VOC detections were evaluated for the overall linear regression calculations. Non-detected results were not included in the evaluation. Linear regression analyses were performed for the groundwater data sets, and the results are summarized in Table 6 of the QCSR for the 354 Area PDI and Groundwater Monitoring Event 1 (Avatar, 2016a). A copy of the QCSR is located in Appendix E-1.

For the groundwater data set, the correlation coefficient between the on-site field GC and off-site confirmation results was 0.99, which exceeded the minimum regression criteria of 0.70 established in the UFP- QAPP. (Avatar, 2016d).

A comparison of the results showed that non-detects and low, mid and high level detections reported by the field GC were comparable to non-detects and low, mid, and high level detections by the off-site laboratory. While one PCE result (354-DP68-GW01) was detected above the PAL by the field GC but below the PAL by the off-site laboratory, all other laboratory results confirmed PCE exceedances of the PAL in groundwater.

4.2.2 Groundwater Monitoring Well Quarterly Sampling

VOCs and metals were detected in groundwater samples collected from monitoring wells at the site from the first and second groundwater quarterly sampling events. Groundwater sampling results are presented in Table 4-10 (detections only). Natural attenuation indicator parameters were also analyzed in groundwater samples from the first and second sampling events. The natural attenuation indicator parameters included MEE, anions (nitrate/nitrite/sulfate/chloride/sulfide), alkalinity, and TOC. In addition to the analytes above, groundwater samples from the first event were analyzed for VFAs and MP. Lab reports for VFA and MP are located in Appendix E-2.

Those detections that exceeded the PALs are shaded on Table 4-10. Groundwater samples exceeded PALs in the case of cis-1,2 DCE, PCE, TCE, dissolved iron, and dissolved manganese. Dissolved iron exceeded the Secondary MCL, which is not enforced. Figure 4-3 depicts VOC detections in groundwater from the first and second sampling events.

4.2.2.1 Volatile Organic Compounds

- Acetone was detected in groundwater samples from the second event in 354-01-27, 354-01-30C, 354-99-12C, 354-99-13C, and TSO292-02. Acetone concentrations ranged from 8.0 µg/L (TSO292-02) to 18 µg/L (354-01-27). Acetone is a common laboratory contaminant. None of the detections of acetone exceeded the PAL of 45,500 µg/L (see Table 4-10).

- Benzene was detected in one groundwater sample from the first event in TSO292-02. Benzene was detected at 1 J µg/L. This detection of benzene did not exceed the PAL of 5 µg/L for benzene (see Table 4-10).

- Chloroform was detected in groundwater samples from the first event in 354-01-27, 354-99-09, TSO292-01, and TSO292-02. Chloroform concentrations ranged from 0.4 J µg/L (354-99-09) to 1.4 J µg/L (TSO292-02). None of the detections of chloroform exceeded the PAL of 80 µg/L (see Table 4-10).

- cis-1,2 DCE was detected in groundwater samples from 354-99-12C (first and second events), TSO292-01 (first and second events), and TSO292-02 (first event). Concentrations of cis-1,2 DCE ranged from 0.64 J µg/L (TSO292-01) to 4.10 µg/L (354-99-12C). None of the detections of cis-1,2 DCE exceeded the PAL of 70 µg/L (see Table 4-10).

- M,p-xylenes was detected in one groundwater sample from the first event in TSO292-02. m,p-xylenes was detected at 0.57 J µg/L. There is no PAL for m,p-xylenes (see Table 4-10).

- PCE was detected in groundwater samples from the first and second events in 354-01-27, 354-99-09, and TSO292-01. PCE concentrations ranged from 5.2 µg/L (354-99-09) to 85 µg/L (354-01-27). All detections exceeded the PAL of 5 µg/L for PCE (see Table 4-10).

- TCE was detected in groundwater samples from 354-01-27 (first event), 354-99-12C (first and second event), and TSO292-01 (first and second event). TCE concentrations ranged from 0.74 J µg/L (354-99-09) to 3.2 µg/L (TSO292-01). None of the detections of TCE exceeded the PAL of 5 µg/L (see Table 4-10).

4.2.2.2 Dissolved Manganese

Dissolved manganese was detected in groundwater samples from the first and second event in 354-01-30C, 354-99-09, 354-99-13C, TSO292-01, and TSO292-02. Dissolved manganese concentrations ranged from 0.01 mg/L (TSO292-01) to 1.56 mg/L (354-01-30C). All of the manganese detections except TSO292-01 exceeded the PAL of 0.05 mg/L (see Table 4-10).

4.2.2.3 Dissolved Iron

Dissolved iron was detected in groundwater samples from the first and second events in 354-01-30C, 354-99-09, 354-99-13C, and TSO292-02. Dissolved iron was also detected in TSO292-01 during the second event. Dissolved iron concentrations ranged from 1.09 mg/L (354-01-30C) to 13.10 mg/L (TSO292-02). All of the detections of dissolved iron exceeded the PAL of 0.3 mg/L (see Table 4-10). The PAL for dissolved iron is based on the Secondary MCL which is not enforceable.

4.2.2.4 Natural Attenuation Indicator Parameters

Based on the results of natural attenuation indicator parameters analysis, it appears that reductive dechlorination is limited across the site. The lack of detections for volatile fatty acids and microbial presence indicated that the environment may not be conducive for reductive dechlorination. In addition, the presence of relatively stable or non-detected concentrations of other indicator parameters also supports the conclusion that reductive dechlorination is limited across the site. A brief discussion of indicator parameter concentrations follows:

4.2.2.4.1 Methane, Ethane, Ethene

Methane was detected in groundwater samples from 345-01-30C, TSO292-01, and TSO292-02. Methane concentrations ranged from non-detect to 134 µg/L (TSO292-02). Detection of methane in groundwater is an indication of very low redox potential of groundwater. During methanogenesis certain anaerobic bacteria break down contaminants to produce methane. Methanogenesis is common in anoxic environments.

Ethane was detected in the groundwater sample from TSO292-02 at a maximum concentration of 1.93 µg/L. There is no PAL for ethane. Ethane is the endpoint of the reductive dechlorination process. Detections of elevated ethane indicate dechlorination is reaching finality. Ethane concentrations greater than 10 µg/L are favorable to reductive dechlorination (USEPA, 1998). Since values of ethane detected were either non-detect or well below 10 µg/L it is unlikely that reductive chlorination is occurring in the terrace or alluvial aquifer.

Ethene was non-detect in all groundwater samples from the first and second sampling events. Ethene is a byproduct of anaerobic reductive dehalogenation of chlorinated solvents. Detections of metabolic byproducts, like ethene, provides evidence that biodegradation is occurring.

4.2.2.4.2 Total Alkalinity (as $CaCO_3$)

Alkalinity (as $CaCO_3$) was detected in all groundwater samples from the first and second sampling events. Alkalinity concentrations ranged from 281 mg/L (354-99-09) to 507 mg/L (TSO292-02) during the first event and 221 mg/L (354-01-27) to 364 mg/L (TSO292-02) during the second event. Alkalinity concentrations considered to be indicative of reductive dechlorination are two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for alkalinity of groundwater from Kansas River alluvial deposits is 340 mg/L, with a range of 170-470 mg/L (Fader, 1974). Average values for alkalinity of groundwater from the terrace aquifer is 408 mg/L, with a range of 376-454 mg/L (LBA, 1996). Therefore, twice the average values are 680 mg/L (alluvial) and 816 mg/L (terrace). Detected values of alkalinity appear to indicate that reductive dechlorination is likely not occurring in the terrace or alluvial aquifers (see Table 4-10).

4.2.2.4.3 Anions (chloride, nitrate, nitrite, sulfate, sulfide)

- Chloride was detected in all groundwater samples from the first and second sampling events. Chloride concentrations ranged from 49.2 mg/L (354-01-30C) to 471 mg/L (354-99-12C) during the first event and 30.6 mg/L (TSO292-02) to 585 mg/L (354-99-09) during the second event. Chloride concentrations which are considered to be indicative of reductive dechlorination are two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for chloride of groundwater from Kansas River alluvial deposits is 28 mg/L, with a range of 3.0-84 mg/L (Fader, 1974). Average values for chloride of groundwater from the terrace aquifer is 43 mg/L, with a range of 6-130 mg/L (LBA, 1996). Therefore, twice the average values are 56 mg/L (alluvial) and 86 mg/L (terrace). Six out of seven chloride values from the first event were greater than two times the background values while four out of seven chloride values from the second event were greater than two times the background value. While these results appear to be indicative of reductive dechlorination is occurring in both the terrace and alluvial aquifers, elevated chloride concentrations could be naturally occurring and previous evidence has indicated that reductive dechlorination is most likely not occurring in the terrace or alluvial aquifers.

- Nitrate was detected in all groundwater samples from the first and second sampling events. Nitrate concentrations ranged from 0.04 J mg/L (354-99-12C) to 11.9 mg/L (354-99-09) during the first event and 0.132 J mg/L (TSO292-02) to 10.5 J mg/L (354-99-09) during the second event. During sampling rounds 1 and 2 localized nitrate results exceeded the MCL in 354-99-09 but concentrations dropped to near non-detect in down-gradient wells. At this time, there is currently no known source for nitrate exceedances in monitoring well 354-99-09.

- Nitrite was detected in only one sample from the second sampling event (TSO292-01). Nitrite concentration was measured at 0.26 mg/L at TSO292-01.

- Sulfate was detected in all groundwater samples from the first and second events. Sulfate concentrations ranged from 8.01 mg/L (TSO292-02) to 169 mg/L (354-99-12C) during the first event and 0.779 J mg/L (TSO292-02) to 171 mg/L (354-99-12C) during the second event.

- Sulfide was detected in groundwater samples from the first and second sampling events in 354-99-13C and TSO292-02. Sulfide concentrations were 0.02 J mg/L (354-99-13C) and 0.11 mg/L (TSO292-02) during the first event. Sulfide concentrations were 0.069 mg/L (354-99-13C) and 0.107 mg/L (TSO292-02) during the second event. Increasing concentrations of sulfide is indicative of sulfate reduction.

Nitrate serves as a terminal electron acceptor through the processes of denitrification and nitrate reduction. Denitrification occurs when nitrate is converted to nitrogen. Nitrate reduction is the process of converting nitrate to nitrite to ammonia. In redox reactions, denitrification is favored over nitrate reduction because microorganisms generate more energy through denitrification. Nitrate reduction will occur as conditions become more reducing. Secondary indicators of bioremediation include nitrate, sulfate, and ferrous iron. Decreased levels of nitrate and sulfate and increased levels of ferrous iron are indicators that biodegradation is occurring within a plume.

4.2.2.4.4 Total Organic Carbon

TOC was detected in all groundwater samples from the first and second sampling events. TOC values ranged from 1.12 mg/L (354-01-27) to 3.26 mg/L (TSO292-02) during the first event and 1.20 mg/L (354-01-27) to 2.40 mg/L (TSO292-02) during the second event. TOC measures the amount of organic carbon from both natural and anthropogenic sources and can be used as an indicator of organic contamination and remediation amendment (chemical oxidant or electron donor) demand (see Table 4-10).

4.2.2.4.5 Volatile Fatty Acids

Samples for VFAs were collected from all monitoring wells during the first sampling event (see Table 4-11) and analyzed for acetic acid, butyric acid, formic acid, hexanoic acid, lactic acid, pantanoic acid, propionic acid, pyruvic acid, i-hexanoic acid, and i-pentanoic acid. VFAs are used as biomarkers of anaerobic metabolism. Anaerobic bacteria produce these compounds by fermentation, while under aerobic conditions these compounds are rapidly oxidized for carbon and energy by aerobic bacteria. The analytical results for all analytes from all monitoring wells were non-detect. The absence of these compounds is an indication that fermentation is not occurring and that the environment may not be conducive for reductive dechlorination.

4.2.2.4.6 Microbial Presence

Samples were collected from all monitoring wells to determine the presence of the microbe Dehalococcoides and the following enzymes; Vinyl Chloride Reductase, tceA Reductase, and BAV1 Vinyl Chloride Reductase (see Table 4-11). Vinyl Chloride Reductase and tceA Reductase were both non-detect in all samples. These enzymes are known to dechlorinate PCE and TCE to ethane. Low concentrations of Dehalococcoides were reported for samples collected from 354-01-30C, TS0292-01, TS0292-02, 354-99-13C, and 354-99-12C. Results range from 1.97E+1 cells/mL (354-99-13C) to 1.50E+2 cells/mL (354-99-12C). Dehalococcoides was non-detect in 354-99-09 and 354-01-27. Dehalococcoides is the only known microorganism to completely dechlorinate PCE and TCE to ethane. Results for BAV1 Vinyl Chloride Reductase were non-detect for all samples except 5.00E-1 J cells/mL in 354-01-30C. The absence of Vinyl Chloride reductases suggests that vinyl chloride may accumulate. Collectively, these results suggest that the potential for complete reductive dechlorination may be limited.

4.2.2.4.7 Field Measurements

Field measurements were collected for each groundwater sample. Field measurements are presented on Table 4-12.

- **Temperature**: Temperature values ranged from 14.06 °C (354-99-12C) to 17.64 °C (354-01-27) during the first event and 15.06 °C (354-01-30C) to 21.82 °C (354-01-27) during the second event. Groundwater temperature directly influences the reductive dechlorination activity of microorganisms in groundwater. Temperatures above 20 °C are favorable for reductive dechlorination. None of the temperature values from the first event were favorable for reductive dichlorination. Two of the seven temperature values (TS0292-02 and 354-01-27) from the second event were favorable for reductive dechlorination.

- **pH**: pH values ranged from 6.09 (354-99-09) to 7.41 (354-01-30C) during the first event and 6.84 (TSO292-01) to 7.32 (354-99-13C) during the second event. Typically, a pH between 5.0 and 9.0 is considered optimal for reductive dechlorination. All values from both events fall within the optimal range for reductive dechlorination.

- **Specific Conductance**: Specific conductance values ranged from 0.0886 mS/cm (354-01-30C) to 6.631 mS/cm (354-99-12C) during the first event and 0.587 mS/cm (TSO292-02) to 1.777 mS/cm (354-99-09) during the second event. Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the number of dissolved solids (such as salt) in the water.

- **ORP**: ORP values ranged from -94.9 mV (354-99-13C) to 103.5 mV (354-01-27) during the first event and -137.9 mV (354-99-13C) to 64.8 mV (TSO292-01) during the second event. ORP is an indicator of electron activity in the groundwater. High ORP readings are typically associated with oxidizing conditions, while low ORP readings are associated with reducing conditions. ORP values less than 50 mV indicate reductive dichlorination is possible while ORP values of less than -100 mV indicates reductive dichlorination is likely to be occurring. Four out of seven ORP values from the first event were below 50 mV indicating reductive dechlorination was possible. Six out of seven ORP values from the second event were below 50 mV indicating reductive dechlorination was possible and one of the values (354-99-13C) was below -100 mV indicating reductive dechlorination was likely to occur.

- **DO**: DO values ranged from 0.28 mg/L (354-99-12C) to 6.96 mg/L (354-99-09) during the first event and 0.41 mg/L (TSO292-02) to 7.22 mg/L (354-01-27) during the second event. DO values greater than 0.5 mg/L but less than 5 mg/L are considered ideal for reductive dechlorination. High DO values (greater than 5 mg/L) can suppress reductive dichlorination. Five out of seven DO values from the first event fall within the ideal range for reductive dechlorination while two values (354-9904 and 354-0127) were above 5 mg/L indicating the reductive dechlorination might be suppressed at these locations. Three out of seven DO values from the second event fall within the ideal range for reductive dechlorination while two values (354-9904 and 354-0127) were above 5 mg/L indicating the reductive dechlorination might be suppressed at these locations.

- **Turbidity**: Turbidity values ranged from 6.3 Nephelometric Turbidity Units (NTUs) (TSO292-02) to 26.4 NTUs (354-99-12C) during the first event and 0.54 NTU (354-99-12C) to 11.19 NTU (354-01-27) during the second event. Turbidity is the amount of particulate matter that is suspended in water.

- **Ferrous Iron**: Ferrous iron values ranged from 0.07 mg/L (TSO292-01) to 3.30 mg/L (TSO292-02, 354-99-12C, and 354-99-13C) during the first event and 0.03 mg/L (354-99-13C) to 4.51 mg/L (354-99-12C) during the second event. Ferric Iron is used as a terminal electron acceptor during anaerobic biodegradation of organic carbon. During this process, ferric iron is reduced to ferrous iron, which may be soluble in water. Ferrous iron concentrations greater than 1 mg/L indicate generally favorable reductive dechlorination conditions. The majority of the ferrous iron values (four out of seven) from the first event were above 1 mg/L indicating favorable conditions for reductive dechlorination. However, the majority of the ferrous iron values from the second event (five out of seven) were below 1 mg/L indicating unfavorable conditions for reductive dechlorination.

5. SUMMARY AND RECOMMENDATIONS

5.1 INVESTIGATION SUMMARY

Field activities at the 354 Area site included the sampling of soil and groundwater using direct-push sampling equipment, two rounds of groundwater sampling using low flow protocols at seven on-site monitoring wells, and the management of IDW. A total of 79 soil and groundwater borings were advanced in the vicinity and down-gradient of the 354 Area site between April 11, 2016 and May 25, 2016, using direct-push sampling equipment. At 10 direct-push boring locations, both soil and groundwater samples were collected. The remaining 69 direct-push boring locations were advanced to bedrock refusal to collect groundwater samples. Soil and groundwater samples were submitted to the on-site field GC for analysis of TCE, PCE, cis-1,2 DCE. Confirmation soil and groundwater samples were shipped for off-site laboratory analysis at a rate of approximately 10 percent. Soil samples were submitted to the off-site laboratory for analysis of VOCs, manganese, TOC, AVS, and BAI. Groundwater samples were submitted to the off-site laboratory for analysis of VOCs and MEE.

5.1.1 Soil Investigation Summary

Analytical results were presented in Tables 4-2, 4-3, and 4-4 and a brief summary for each of the analytes detected in soil follows:

- PCE was detected in field GC soil samples collected from one or more intervals from all direct-push borings from which soil samples were collected. PCE was detected in six of the eleven soil samples collected and shipped for off-site laboratory analysis. None of the soil samples collected at any of the direct-push borings exceeded the PAL of 210,000 µg/kg for PCE.

- TCE was detected in soil samples collected from one or more intervals in two of the ten direct-push borings from which soil samples were collected. TCE was detected in three of eleven soil samples analyzed at the off-site laboratory. None of the soil sample concentrations detected exceeded the PAL of 9,910 µg/kg for TCE.

- cis-1,2 DCE was detected in soil samples collected from one or more intervals in nine of the ten direct-push borings from which soil samples were collected. Three of eleven soil samples detected cis-1,2 DCE and were shipped for off-site laboratory analysis. None of the soil samples concentrations detected exceeded the PAL of 38,700 µg/kg for cis-1,2 DCE.

- Manganese was detected in all samples collected and shipped for off-site laboratory analysis. None of the soil sample concentrations detected exceeded the PAL of 22,067 mg/kg for manganese.

- BAI was detected in all samples analyzed at the off-site laboratory. There is no established PAL for BAI. The presence of BAI in soils, although at low concentrations, along with generally unfavorable reducing conditions in the terrace aquifer indicates sulfate-reducing or methanogenic conditions are not likely occurring near Building 367.

- AVS was not detected in any samples analyzed at the off-site laboratory. The absence of AVS in soils indicates that sulfate reduction is not likely occurring near Building 367.

No analytes detected by the field GC or off-site laboratory in soil samples exceeded the PAL. Detections of analytes are limited to the area adjacent to Building 367 and concentrations vary at depth (see Figure 4-1).

5.1.2 Groundwater Investigation Summary - Direct-Push Probes

Analytical results are located on Table 4-6 and 4-8 (detections only) and a brief summary for each of the analytes detected in groundwater follows:

- Acetone was detected in two of eleven samples analyzed at the off-site laboratory. None of the groundwater sample concentrations exceeded the PAL of 45,500 µg/L for acetone.

- Benzene was detected in three of eleven samples analyzed at the off-site laboratory. One groundwater sample (Boring DP-41) exceeded the PAL of 5 µg/L for benzene.

- Chloroform was detected in five of eleven samples analyzed at the off-site laboratory. None of the groundwater sample concentrations exceeded the PAL of 80 µg/L for chloroform.

- cis-1,2 DCE was detected in groundwater samples collected from 14 of 79 total direct-push borings. None of the groundwater samples concentrations detected exceeded the PAL of 70 µg/L based on field GC results. Eight of eleven samples detected cis-1,2 DCE and were analyzed at the off-site laboratory, of which one groundwater sample (Boring DP-21) exceeded the PAL of 70 µg/L.

- Ethylbenzene was detected in four of eleven samples analyzed at the off-site laboratory. None of the groundwater sample concentrations exceeded the PAL of 700 µg/L for ethylbenzene.

- Naphthalene was detected in two of eleven samples analyzed at the off-site laboratory. One groundwater sample (Boring DP-41) exceeded the PAL of 2.11 µg/L for naphthalene.

- PCE was detected in groundwater samples collected from 53 of 79 total direct-push borings. Thirty-two of these samples exceeded the PAL of 5 µg/L for PCE based on field GC results. PCE was detected in seven of eleven groundwater samples analyzed at the off-site laboratory, of which four samples (Borings DP-18, 21, 11, and 42) exceeded the PAL of 5 µg/L.

- Toluene was detected in seven of eleven samples analyzed at the off-site laboratory. None of the groundwater sample concentrations exceeded the PAL of 1,000 µg/L for toluene.

- trans-1,2 DCE was detected in one sample analyzed at the off-site laboratory. This groundwater sample did not exceed the PAL of 100 µg/L for trans-1,2 DCE.

- TCE was detected in groundwater samples collected from six of 79 total direct-push borings. Four of these samples exceeded the PAL of 5 µg/L. TCE was detected in seven of eleven samples analyzed at the off-site laboratory, of which one groundwater sample (Boring DP-21) exceeded the PAL of 5 µg/L for TCE.

The PCE plume delineated in this investigation extends from north to south starting in the suspected source are (Building 367) to approximately 300 ft south of the railroad tracks. The plume is approximately bound by Holbrooke Avenue and Henry Drive on the western edge and by Building 338 on the eastern side (see Figure 2-1).

5.1.3 Groundwater Investigation Summary - Quarterly Monitoring

Groundwater monitoring activities are ongoing at the 354 Area site following the findings of the ESD, to determine the current groundwater geochemical conditions and potential remediation actions. Avatar completed the first and second of eight quarterly groundwater sampling events in May 2016 and August 2016. Groundwater samples were submitted to the off-site laboratory for analysis of VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), iron (dissolved), VFAs, and MP (first event only).

A brief summary for each of the analytes detected in groundwater follows:

- Acetone was detected in groundwater samples from the second event in 354-01-27, 354-01-30C, 354-99-12C, 354-99-13C, and TSO292-02. None of the detections of acetone exceeded the PAL of 45,500 µg/L.

- Benzene was detected in one groundwater sample from the first event in TSO292-02. Benzene was detected at 1 J µg/L. This detection of benzene did not exceed the PAL of 5 µg/L for benzene.

- Chloroform was detected in groundwater samples from the first event in 354-01-27, 354-99-09, TSO292-01, and TSO292-02. None of the detections of chloroform exceeded the PAL of 80 µg/L.

- cis-1,2 DCE was detected in groundwater samples from 354-99-12C (first and second events), TSO292-01 (first and second events), and TSO292-02 (first event). None of the detections of cis-1,2 DCE exceeded the PAL of 70 µg/L.

- M,p-xylenes was detected in one groundwater sample from the first event in TSO292-02. m,p-xylenes was detected at 0.57 J µg/L. There is no PAL for m,p-xylenes.

- PCE was detected in groundwater samples from the first and second events in 354-01-27, 354-99-09, and TSO292-01. All detections exceeded the PAL of 5 µg/L for PCE.

- TCE was detected in groundwater samples from 354-01-27 (first event), 354-99-12C (first and second event), and TSO292-01 (first and second event). None of the detections of TCE exceeded the PAL of 5 µg/L.

- Dissolved manganese was detected in groundwater samples from the first and second event in 354-01-30C, 354-99-09, 354-99-13C, TSO292-01, and TSO292-02. All of the manganese detections except TSO292-01 exceeded the PAL of 0.05 mg/L.

- Dissolved iron was detected in groundwater samples from the first and second events in 354-01-30C, 354-99-09, 354-99-13C, and TSO292-02. All the detections of dissolved iron exceeded the PAL of 0.3 mg/L. The PAL for dissolved iron is based on the Secondary MCL which is not enforceable.

As discussed in the ESD, concentrations of PCE began to rebound in the terrace monitoring wells in March 2014. However, analytical results from the May and August 2016 sampling events have indicated levels of PCE now appear to be sharply declining (see Figure 5-1). If the current trend continues, active remediation may not be necessary. PCE contamination has impacted terrace monitoring wells while transition and alluvial monitoring wells have not been impacted (see Figure 4-3). The following recommendations were formulated based on the current downward trend in PCE results in the terrace wells.

5.2 RECOMMENDATIONS

Direct-push soil sample results from both the field GC and off-site laboratory indicated concentrations of PCE, TCE, and cis-1,2 DCE well below their PALs. Based on the analytical results for soil samples taken in the vicinity of Building 367 and the former source area, there does not appear to be a secondary source area in vadose zone soils. Additional investigation and remediation to soils in this area does not appear to be warranted.

Direct-push groundwater results from both the field GC and off-site laboratory indicated that concentrations of PCE and TCE exceeded their PALs south of the source area and extending down gradient. The extent of PCE and TCE contamination is bound by direct-push groundwater borings with detections below the PALs, non-detections, or no groundwater encountered.

The short-term recommendation is to complete the remaining six rounds of quarterly groundwater sampling. Based on the results of the remaining six rounds of quarterly groundwater sampling, additional long-term recommendations may be considered. Three potential long-term recommendation scenarios are presented below.

Long-Term Recommendation Scenario 1

If after the completion of the six remaining groundwater sampling events, contaminant concentrations are below the April 2012 levels, then Recommendation Scenario 1 may include:

- Install a monitoring well inside the Public Works compound near the location of the highest field GC results DP-54 to provide better plume coverage for monitoring contaminant concentrations.
- Install an additional down gradient monitoring well approximately 450 ft south of Monitoring Well TSO292-02, between DP-67 and DP-68 to provide a monitoring point within the Kansas River alluvial aquifer.
- Proceed with annual groundwater sampling. Sample all site monitoring wells for VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), and iron (dissolved) to assure contaminant concentrations are continuing to decrease to meet the cleanup goals and remedial action objectives defined in the ROD.

If at any point during annual groundwater sampling, contaminant concentrations increase sharply, perform a confirmation sampling event as soon as possible. If the results of the confirmation sampling event confirm the results of the original sampling event, then Recommendation Scenario 3 below could be considered (without monitoring well installation).

Long-Term Recommendation Scenario 2

If after the completion of the six remaining groundwater sampling events, contaminant concentrations continue to show a downward trend toward the April 2012 levels, then Recommendation Scenario 2 may include:

- Install a monitoring well inside the Public Works compound near the location of the highest field GC results DP-54 to provide better plume coverage for monitoring contaminant concentrations.
- Install an additional down gradient monitoring well approximately 450 ft south of Monitoring Well TSO292-02, between DP-67 and DP-68, to provide an additional monitoring point within the Kansas River alluvial aquifer.
- Conduct two years of semi-annual groundwater sampling from all site monitoring wells for VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), and iron (dissolved) to assure contaminant concentrations are continuing to decrease to meet the cleanup goals and remedial action objectives defined in the ROD.
- Following the two years of semi-annual sampling, conduct annual groundwater sampling from all site monitoring wells for VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), iron (dissolved) to assure contaminant concentrations are continuing to decrease to meet the cleanup goals and remedial action objectives defined in the ROD.
- Conduct annual monitoring until all sampling results are less than the MCLs for three consecutive events. At that point a decision on whether to discontinue sampling would be discussed with the regulatory partners.

If at any point during semi-annual or annual groundwater sampling, contaminant concentrations sharply increase, a confirmation sampling event would be performed immediately. If the results of the confirmation sampling event confirm the results of the original sampling event then recommendations in Recommendation Scenario 3 would be followed, (without the monitoring well installation).

Long-Term Recommendation Scenario 3

If after the completion of the six remaining groundwater sampling events, contaminant concentrations do not continue to show a downward trend to near or below their April 2012 levels, or contaminant concentrations increase again, then Recommendation Scenario 3 may include:

  - Install a monitoring well inside the Public Works compound near the location of the highest field GC results DP-54 to provided better plume coverage for monitoring contaminant concentrations.

  - Install an additional down gradient monitoring well approximately 450 ft south of Monitoring Well TSO292-02, between DP-67 and DP-68, to provide an additional monitoring point within the Kansas River alluvial aquifer.

- Perform in-situ chemical oxidation (ISCO) injection using a chemical substrate such as potassium or sodium permanganate. ISCO injection curtains will consist of multiple injection points with overlapping radii of influence installed perpendicular to the contaminant plume in the up-gradient and down-gradient directions of the monitoring wells located on the terrace. The ISCO injection curtains should be based on the contaminant transport for a one year period utilizing site-specific groundwater velocities. Specific design details, locations of injection points, pilot tests, bench scale tests, specific ISCO substrate, and volumes to be used would be provided in a remedial design/remedial action work plan.

- Following ISCO treatment, conduct one year of post-performance monitoring, consisting of quarterly groundwater sampling from all site monitoring wells for VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), and iron (dissolved) to assess the effectiveness and progress of the remediation.

- Depending on the outcome of the post-performance monitoring, a second and third year of semi-annual sampling could be conducted. The analytical suite for the second and third year of sampling would remain the same as year one.

- Based on the results after one year of post-performance monitoring, additional ISCO injection treatments may be required.

- If all sampling results are less than the MCLs for the three consecutive events, discuss with regulatory partners whether to discontinue sampling.

- If additional ISCO injection treatments are required, then conduct another two years of post-performance monitoring.

- If required, following post-performance monitoring, conduct annual groundwater sampling from all site monitoring wells for VOCs, MEE, alkalinity, anions, sulfide, TOC, manganese (dissolved), iron (dissolved) to assure contaminant concentrations are continuing to decrease to meet the cleanup goals and remedial action objectives defined in the ROD.

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Tables

Table 4-1
Summary of Groundwater Elevations - May and August 2016
354 Area PDI Report
Fort Riley, Kansas

	May 2016			August 2016		
Well ID	Elevation TOC (ft MSL)	Depth to Water (ft BTOC)	Water Level Elevation (ft MSL)	Elevation TOC (ft MSL)	Depth to Water (ft BTOC)	Water Level Elevation (ft MSL)
354-01-27	1116.38	52.08	1064.30	1116.38	50.81	1065.57
354-99-09	1091.12	31.68	1059.44	1091.12	31.24	1059.88
TS0292-01	1084.12	24.68	1059.44	1084.12	23.9	1060.22
TS0292-02	1066.02	12.15	1053.87	1066.02	13.12	1052.90
354-99-12C	1061.29	22.42	1038.87	1061.29	20.74	1040.55
354-99-13C	1061.79	23.15	1038.64	1061.79	21.4	1040.39
354-01-30C	1051.76	13.68	1038.08	1051.76	11.72	1040.04

Notes:

ft - feet

MSL - mean sea level

TOC - top of casing

BTOC - below top of casing

Table 4-2
Soil Sample Field GC Results
354 Area PDI Report
Fort Riley, Kansas

			Analyte	PCE	TCE	cis-1,2 DCE
			Units	ug/kg	ug/kg	ug/kg
			PAL	210,000	9,910	38,700
			PAL Reference	RSK	RSK	RSK
Boring Location:	Sample ID:	Date:	Depth (ft):			
DP01	DP01/SB01/3-4'	4/13/2016	3-4'	12.6 U	12.6 U	12.6 U
	DP01/SB02/9-10'	4/13/2016	9-10'	12.6 U	12.6 U	12.6 U
	DP01/SB03/12-13'	4/13/2016	12-13'	12.6 U	12.6 U	12.6 U
	DP01/SB04/19-20'	4/13/2016	19-20'	12.6 U	12.6 U	12.6 U
	DP01/SB05/22-23'	4/13/2016	22-23'	12.6 U	12.6 U	6.6 J
	DP01/SB05/22-23' (Duplicate)	4/13/2016	22-23'	12.6 U	12.6 U	5.2 J
	DP01/SB06/28-29'	4/13/2016	28-29'	12.6 U	12.6 U	6.2 J
	DP01/SB07/33-34'	4/13/2016	33-34'	24.6 J	12.6 U	17.5 J
	DP01/SB08/38-39'	4/13/2016	38-39'	12.6 U	12.6 U	5.8 J
	DP01/SB09/44-45'	4/13/2016	44-45'	12.6 U	12.6 U	8.6 J
	DP01/SB10/48-49'	4/13/2016	48-49'	12.6 U	12.6 U	8.6 J
DP02	DP02/SB01/4-'5	4/14/2016	4-'5	6.0 J	12.6 U	7.6 J
	DP02/SB02/7-8'	4/14/2016	7-8'	12.6 U	12.6 U	22.1J
	DP02/SB03/14-15'	4/14/2016	14-15'	12.6 U	12.6 U	4.6 J
	DP02/SB04/19-20'	4/14/2016	19-20'	12.6 U	12.6 U	12.6 U
	DP02/SB05/22.5-23.5'	4/14/2016	22.5-23.5'	12.6 U	12.6 U	12.6 U
	DP02/SB06/27-28'	4/14/2016	27-28'	12.6 U	12.6 U	12.6 U
	DP02/SB07/34-35'	4/14/2016	34-35'	12.6 U	12.6 U	12.6 U
	DP02/SB08/37-38'	4/14/2016	37-38'	12.6 U	12.6 U	12.6 U
	DP02/SB08/37-38' (Duplicate)	4/14/2016	37-38'	12.6 U	12.6 U	12.6 U
	DP02/SB09/40-41'	4/14/2016	40-41'	12.6 U	12.6 U	12.6 U
DP03	DP03/SB01/4-5'	4/19/2016	4-5'	63.7	12.6 U	12.6 U
	DP03/SB02/5-6'	4/19/2016	5-6'	13.6	12.6 U	12.6 U
	DP03/SB03/12-13'	4/19/2016	12-13'	12.6 U	12.6 U	12.6 U
	DP03/SB04/16-17'	4/19/2016	16-17'	12.6 U	12.6 U	12.6 U
	DP03/SB05/22-23'	4/19/2016	22-23'	15.5	12.6 U	12.6 U
	DP03/SB06/29-30'	4/19/2016	29-30'	40.4	12.6 U	12.6 U
	DP03/SB07/33-34'	4/19/2016	33-34'	82.4	12.6 U	12.6 U
	DP03/SB08/36-37'	4/19/2016	36-37'	64.4	12.6 U	12.6 U
	DP03/SB09/42-43'	4/19/2016	42-43'	170	12.6 U	12.6 U
	DP03/SB10/49-50'	4/19/2016	49-50'	158	12.6 U	12.6 U
	DP03/SB10/49-50' (Duplicate)	4/19/2016	49-50'	168	12.6 U	19.1 J
DP06	DP06/SB01/1-2'	4/18/2016	1-2'	63	12.6 U	12.6 U
	DP06/SB02/8-9'	4/18/2016	8-9'	12.6 U	12.6 U	12.6 U
	DP06/SB03/14-15'	4/18/2016	14-15'	12.6 U	12.6 U	12.6 U
	DP06/SB04/17-18'	4/18/2016	17-18'	12.6 U	12.6 U	12.6 U
	DP06/SB05/20-22'	4/18/2016	20-22'	26	12.6 U	12.6 U
	DP06/SB06/28-30'	4/18/2016	28-30'	25.8	12.6 U	12.6 U
	DP06/SB07/30-32'	4/18/2016	30-32'	15.9	12.6 U	12.6 U
	DP06/SB08/37-39'	4/18/2016	37-39'	25.5	12.6 U	12.6 U
	DP06/SB09/43-45'	4/18/2016	43-45'	29.4	12.6 U	12.6 U
	DP06/SB10/46-48'	4/18/2016	46-48'	166	12.6 U	19.9 J

Table 4-2
Soil Sample Field GC Results
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Fort Riley, Kansas

			Analyte	PCE	TCE	cis-1,2 DCE
			Units	ug/kg	ug/kg	ug/kg
			PAL	210,000	9,910	38,700
			PAL Reference	RSK	RSK	RSK
Boring Location:	Sample ID:	Date:	Depth (ft):			
DP07	DP07/SB01/4-5'	4/20/2016	4-5'	53.8	12.6 U	12.6 U
	DP07/SB02/8-9'	4/20/2016	8-9'	16.1	12.6 U	12.6 U
	DP07/SB03/14-15'	4/20/2016	14-15'	12.6 U	12.6 U	12.6 U
	DP07/SB04/18-19'	4/20/2016	18-19'	12.6 U	12.6 U	12.6 U
	DP07/SB05/23-24'	4/20/2016	23-24'	17.9	12.6 U	12.6 U
	DP07/SB06/26-27'	4/20/2016	26-27'	46.6	12.6 U	12.6 U
	DP07/SB07/34-35'	4/20/2016	34-35'	159	12.6 U	12.6 U
	DP07/SB08/39-40'	4/20/2016	39-40'	78.6	12.6 U	12.6 U
	DP07/SB09/44-45'	4/20/2016	44-45'	237	29.4	36.4
	DP07/SB09/44-45'	4/20/2016	44-45'	193	30.2	29.4
	DP07/SB10/49-50'	4/20/2016	49-50'	260	33.9	50.1
DP08	DP08/SB01/4-5'	4/18/2016	4-5'	42	12.6 U	19.4
	DP08/SB01/4-5' (Duplicate)	4/18/2016	4-5'	48	12.6 U	21.8
	DP08/SB02/9-10'	4/18/2016	9-10'	12.6 U	12.6 U	12.6 U
	DP08/SB03/13-14'	4/18/2016	13-14'	12.6 U	12.6 U	13.9
	DP08/SB04/18-19'	4/18/2016	18-19'	12.6 U	12.6 U	12.8
	DP08/SB05/21-22'	4/18/2016	21-22'	16.7	12.6 U	12.6 U
	DP08/SB06/28-29'	4/18/2016	28-29'	41.3	12.6 U	12.6 U
	DP08/SB07/34-35'	4/18/2016	34-35'	86.2	12.6 U	16.2 J
	DP08/SB08/39-40'	4/18/2016	39-40'	48.1	12.6 U	12.6 U
	DP08/SB09/44-45'	4/18/2016	44-45'	78.7	12.6 U	20.6 J
	DP08/SB10/49-50'	4/18/2016	49-50'	103	12.6 U	28.8
	DP08/SB10/49-50' (Duplicate)	4/18/2016	49-50'	81.1	12.6 U	33.2
DP09	DP09/SB01/2.5-3.5'	4/15/2016	2.5-3.5'	30.5	12.6 U	12.6 U
	DP09/SB02/9-10'	4/15/2016	9-10'	12.6 U	12.6 U	12.6 U
	DP09/SB03/11.5-12.5'	4/15/2016	11.5-12.5'	12.6 U	12.6 U	12.6 U
	DP09/SB04/16-17'	4/15/2016	16-17'	12.6 U	12.6 U	29.8
	DP09/SB05/22-23'	4/15/2016	22-23'	12.6 U	12.6 U	20.4 J
	DP09/SB06/26-27'	4/15/2016	26-27'	27.5	12.6 U	22.1 J
	DP09/SB07/33-34'	4/15/2016	33-34'	12.6 U	12.6 U	26
	DP09/SB08/39-40'	4/15/2016	39-40'	24.8 J	12.6 U	21.6 J
	DP09/SB09/44-44'	4/15/2016	44-44'	12.6 U	12.6 U	26.6
	DP09/SB10/46-47'	4/15/2016	46-47'	12.6 U	12.6 U	12.6 U
DP10	DP10/SB01/2-3'	4/11/2016	2-3'	10.9	12.6 U	12.6 U
	DP10/SB02/7-8'	4/11/2016	7-8'	15.7	12.6 U	12.6 U
	DP10/SB03/12-13'	4/11/2016	12-13'	12.6 U	12.6 U	12.6 U
	DP10/SB04/16-17'	4/11/2016	16-17'	12.6 U	12.6 U	12.6 U
	DP10/SB05/22.5-23.5'	4/11/2016	22.5-23.5'	13	12.6 U	12.6 U
	DP10/SB06/29-30'	4/11/2016	29-30'	36.8	12.6 U	12.6 U
	DP10/SB07/31-32.5'	4/11/2016	31-32.5'	65.1	12.6 U	12.6 U
	DP10/SB08/38-39'	4/11/2016	38-39'	107	14.3	15.8
	DP10/SB08/38-39' (Duplicate)	4/11/2016	38-39'	91.7	13.1	16.9

Table 4-2
Soil Sample Field GC Results
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Fort Riley, Kansas

			Analyte	**PCE**	**TCE**	**cis-1,2 DCE**
			Units	**ug/kg**	**ug/kg**	**ug/kg**
			PAL	**210,000**	**9,910**	**38,700**
			PAL Reference	**RSK**	**RSK**	**RSK**
Boring Location:	**Sample ID:**	**Date:**	**Depth (ft):**			
DP11	DP11/SB01/2-3'	4/12/2016	2-3'	31.5	12.6 U	12.6 U
	DP11/SB02/6-7'	4/12/2016	6-7'	28.5	12.6 U	12.6 U
	DP11/SB03/12.5-13.5'	4/12/2016	12.5-13.5'	12.6 U	12.6 U	12.6 U
	DP11/SB04/16.5-17.5'	4/12/2016	16.5-17.5'	ND	12.6 U	34.6
DP12	DP12/SB01/2.5-3.5'	4/12/2016	2.5-3.5'	39.8	12.6 U	12.6 U
	DP12/SB02/8.5-9.5'	4/12/2016	8.5-9.5'	12.6 U	12.6 U	12.6 U
	DP12/SB03/11.5-12.5'	4/12/2016	11.5-12.5'	12.6 U	12.6 U	12.6 U
	DP12/SB04/16.5-17.5'	4/12/2016	16.5-17.5'	12.6 U	12.6 U	12.6 U

Notes:

Bold, shaded indicates action limit exceedance.

J = Estimated value

PAL = Project Action Level

RSK = KDHE Non-Residential Soil Risk-Based Standard (March 2014)

ug/kg = micrograms per kilogram

N/A = not available

Table 4-3
Laboratory Soil Sample Analytical Results (Detections only)
354 Area PDI Report
Fort Riley, Kansas

	Analyte	**PCE**	**TCE**	**cis-1,2-DCE**	**Mn**	**Percent Moisture**	**Total Organic Carbon**
	Units	µg/Kg	µg/Kg	µg/Kg	mg/Kg	%	%-dry
	PAL	210,000	9,910	38,700	22,067	NA	NA
	PAL Reference	RSK	RSK	RSK	RSK	NA	NA
Sample ID:	**Date:**						
354-DP01-SB07-33-34	4/13/2016	1.1 U	3.8 U	3.8 U	198	16.4	0.203
354-DP01-SB77-33-34	4/13/2016	1.1 U	3.6 U	3.6 U	191	15.4	0.246
354-DP02-SB02-7-8	4/14/2016	1 U	3.4 U	3.4 U	190	10.9	0.152
354-DP03-SB09-42-43	4/19/2016	74	3.3 J	2.9 J	60	15.4	0.06 U
354-DP03-SB99-42-43	4/19/2016	63	2.8 J	2.3 J	86.7	15.3	0.06 U
354-DP06-SB01-1-2	4/15/2016	4.6 J	3.9 U	3.9 U	182	14.8	1.7
354-DP06-SB10-46-48	4/18/2016	11	3.9 U	3.9 U	117	14.6	0.06 U
354-DP07-SB10-49-50	4/20/2016	160 R	9.5 J	21 J	35.8	20.1	0.06 U
354-DP08-SB02-9-10	4/18/2016	2.4 J	3.8 U	3.8 U	413	15.3	0.24
354-DP09-SB10-46-47	4/15/2016	1.2 U	3.9 U	3.9 U	223	11.5	0.06 U
354-DP10-SB08-38-39	4/11/2016	24	1.9 J	6.2	213	15.5	0.06 U
354-DP11-SB04-16.5-17.5	4/12/2016	1.2 U	4 U	4 U	22.1	7.9	0.06 U
354-DP12-SB01-2.5-3.5	4/12/2016	8.1	4.3 U	4.3 U	198	15.2	1.46

Notes:

Bold, shaded indicates action limit exceedence

J = Estimated value

R = Data rejected

U = Compound was not detected

NA = not available

mg/kg = milligrams per kilogram

PAL = Project Action Level based on RSK = KDHE Non-Residential Soil Risk-Based Standard (March 2014)

µg/Kg = micrograms per kilogram

% dry = Percent Dry Weight

KDHE RSK at HQ=1 or TR=1E-05 (September, 2015)

HQ = Hazard Quotient

TR = Target Risk

ND = not detected

Mn = Manganese

Table 4-4
Bioavailable Ferric Iron Acid Volatile Sulfides Results
354 Area PDI Report
Fort Riley, Kansas

	Analyte	**Bioavailable Ferric Iron**	**Acid Volatile Sulfides**
	Units	g/Kg	mg/Kg
	PAL	NA	NA
Sample ID:	**Date:**		
354-DP10-SB08-38-39	4/11/2016	1.1	ND
354-DP11-S804-16.5-17 .5	4/12/2016	1.8	ND
354-DP12-SB01-2.5-3.5	4/12/2016	3.1	ND
354-DP01-SB07-33-34	4/13/2016	2.5	ND
354-DP02-SB02-7-8	4/14/2016	2.3	ND
354-DP06-SB01-1-2	4/15/2016	3.0	ND
354-DP09-SB10-46-47	4/15/2016	3.5	ND
354-DPO6-SB10-46-48	4/18/2016	1.4	ND
354-DP08-SB02-9-10	4/18/2016	4.2	ND
354-DP03-SB09-42-43	4/19/2016	0.83	ND
354-DP07-SB10-49-50	4/20/2016	0.83	ND

Notes:

g/Kg = grams per kilogram
PAL = Project Action Level
mg/kg = milligram per kilogram
ND = not detected
NA = not available

Table 4-5
Comparison of Field GC and Laboratory Results - Soil
354 Area PDI Report
Fort Riley, Kansas

Sample ID:	Date Sampled	On-site GC Analysis (EPS) results in ppb			Off-site Confirmation Analysis (ALS) results in ug/kg		
		cis-,1,2-DCE	TCE	PCE	cis-,1,2-DCE	TCE	PCE
354-DP10-SB08-38-39	4/11/2016	16.9	13.1	91.7	6.2	1.9 J	24
354-DP11-SB04-16.5-17.5	4/12/2016	25.2 U	25.2 U	34.6	4 U	4 U	1.2 U
354-DP12-SB01-2.5-3.5	4/12/2016	25.2 U	25.2 U	39.8	4.3 U	4.3 U	8.1
354-DP01-SB07-33-34	4/13/2016	17.5 J	25.2 U	24.6 J	3.8 U	3.8 U	1.1 U
354-DP02-SB02-7-8	4/14/2016	22.1 J	25.2 U	25.2 U	3.4 U	3.4 U	1 U
354-DP06-SB01-1-2	4/15/2016	25.2 U	25.2 U	63	3.9 U	3.9 U	4.6 J
354-DP09-SB10-46-47	4/15/2016	23.4 J	25.2 U	25.2 U	3.9 U	3.9 U	1.2 U
354-DP06-SB10-46-48	4/18/2016	19.9 J	25.2 U	166	3.9 U	3.9 U	11
354-DP08-SB02-9-10	4/18/2016	12.6 U	12.6 U	12.6 U	3.8 U	3.8 U	2.4 J
354-DP03-SB09-42-43	4/19/2016	25.2 U	25.2 U	96.9	2.9 J	3.3 J	74
354-DP07-SB10-49-50	4/20/2016	50.1	33.9	312	21 J	9.5 J	160 R

cis-1,2-DCE = cis-1,2-Dichloroethene
EPS = Environmental Priority Services, Inc.
GC = Gas Chromatograph
J = Estimated value.
ppb = parts per billion
PCE = Tetrachloroethene

R = Data was rejected
U = Compound was not detected. Value is the reporting limit.
µg/kg = micrograms per kilogram
TCE = Trichloroethene

Table 4-6
Groundwater Sample Field GC Results - Detections Only
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	Analyte	**PCE**	**TCE**	**cis-1,2 DCE**
	Units	ug/L	ug/L	ug/L
	PAL	5	5	70
	PAL Reference	MCL	MCL	MCL
Sample ID:	**Date:**			
DP01/GW01	4/13/2016	3 U	3 U	3 U
DP02/GW01	4/14/2016	3 U	3 U	3 U
DP03/GW01	4/19/2016	3.8	3 U	3.8
DP06/GW01	4/18/2016	4.6	3 U	4.6
DP07/GW01	4/20/2016	3.6	3 U	3.6
DP08/GW01	4/18/2016	4.3	3 U	4.3
DP09/GW01 (Duplicate)	4/15/2016	**25.1**	**5.1**	25.1
DP09/GW01	4/15/2016	**20**	4.1	20
DP10/GW01	4/11/2016	3.4	3 U	3.4
DP11/GW01	4/12/2016	4.8	3 U	4.8
DP11/GW01 (Duplicate)	4/12/2016	4.6	3 U	4.6
DP12/GW01	4/12/2016	3 U	3 U	3 U
DP14/GW01	4/12/2016	3.4	3 U	3.4
DP15/GW01	4/12/2016	3.9	3 U	3.9
DP17/GW01	4/13/2016	**6.7**	3 U	6.7
DP18/GW01	4/12/2016	**9.6**	3 U	9.6
DP19/GW01	4/13/2016	3 U	3 U	3 U
DP19/GW01 (Duplicate)	4/13/2016	3 U	3 U	3 U
DP20/GW01	4/13/2016	**6.8**	3 U	6.8
DP21/GW01	4/13/2016	**80.6**	**10.4**	**80.6**
DP22/GW01	4/14/2016	3 U	3 U	3 U
DP23/GW01	4/22/2016	3.1	3 U	3.1
DP24/GW01	4/14/2016	Dry	Dry	Dry
DP24A/GW01	4/13/2016	**5.2**	3 U	5.2
DP25/GW01	4/15/2016	**39.3**	3 U	39.3
DP26/GW01	4/22/2016	**6.6**	3 U	6.6
DP27/GW01	4/21/2016	3 U	3 U	3 U
DP28/GW01	4/19/2016	**5.7**	3 U	5.7
DP29/GW01	4/15/2016	**6.9**	3 U	6.9
DP30/GW01	4/21/2016	4.6	3 U	4.6
DP31/GW01	4/21/2016	**23**	3.9	23
DP31/GW01 (Duplicate)	4/21/2016	**21.8**	4	21.8
DP32/GW01	4/19/2016	**7.8**	3 U	7.8
DP33/GW01	4/21/2016	**7.4**	3 U	7.4
DP34/GW01	4/21/2016	**39.8**	4.7	39.8
DP34/GW01 (Duplicate)	4/21/2016	**46.7**	**5.4**	46.7
DP35/GW01	4/19/2016	Dry	Dry	Dry
DP35A/GW01	4/20/2016	**6**	3 U	6

Table 4-6
Groundwater Sample Field GC Results - Detections Only
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	Analyte	**PCE**	**TCE**	**cis-1,2 DCE**
	Units	ug/L	ug/L	ug/L
	PAL	5	5	70
	PAL Reference	MCL	MCL	MCL
Sample ID:	**Date:**			
DP36/GW01	4/21/2016	**5.1**	3 U	5.1
DP36/GW01 (Duplicate)	4/21/2016	4.6	3 U	4.6
DP37/GW01	4/22/2016	**15.6**	3 U	15.6
DP38/GW01	4/19/2016	**24.9**	3.1	24.9
DP39/GW01	4/21/2016	Dry	Dry	Dry
DP40/GW01	4/25/2016	Dry	Dry	Dry
DP41/GW01	4/22/2016	3 U	3 U	3 U
DP42/GW01	4/22/2016	**16.2**	3 U	16.2
DP43/GW01	4/21/2016	**5.8**	3 U	5.8
DP43/GW02	4/21/2016	**5.4**	3 U	5.4
DP44/GW01	4/20/2016	**6.4**	3 U	6.4
DP44/GW02	4/20/2016	4.1	3 U	4.1
DP45/GW01	4/20/2016	4.3	3 U	4.3
DP45/GW02	4/20/2016	4.7	3 U	4.7
DP46/GW01	4/21/2016	5	3 U	5
DP46/GW02	4/21/2016	4.7	3 U	4.7
DP47/GW01	4/26/2016	3 U	3 U	3 U
DP47/GW02	4/26/2016	3 U	3 U	3 U
DP49/GW01	4/14/2016	3 U	3 U	3 U
DP50/GW01	4/14/2016	3 U	3 U	3 U
DP51/GW01	4/14/2016	**21.6**	3 U	21.6
DP52/GW01	4/25/2016	**9.4**	3 U	9.4
DP53/GW01	4/25/2016	**5.6**	3 U	5.6
DP54/GW01	4/25/2016	**76.9**	**8**	**76.9**
DP55/GW01	4/25/2016	**7.5**	3 U	7.5
DP56/GW01	4/25/2016	**9.9**	3 U	9.9
DP57/GW01	4/25/2016	4.4	3 U	4.4
DP58/GW01	4/26/2016	3 U	3 U	3 U
DP59/GW01	4/25/2016	3 U	3 U	3 U
DP60/GW01	4/27/2015	3 U	3 U	3 U
DP61/GW01	4/27/2016	Dry	Dry	Dry
DP62/GW01	4/26/2016	4.5	3 U	4.5
DP63/GW01	4/26/2016	3 U	3 U	3 U
DP64/GW01	4/26/2016	**8.9**	3 U	8.9
DP64/GW01 (Duplicate)	4/26/2016	**10.3**	3 U	10.3
DP65/GW01	4/27/2016	**9.1**	3 U	9.1
DP66/GW01	4/27/2016	Dry	Dry	Dry
DP67/GW01	4/27/2016	3 U	3 U	3 U

Table 4-6
Groundwater Sample Field GC Results - Detections Only
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	Analyte	**PCE**	**TCE**	**cis-1,2 DCE**
	Units	ug/L	ug/L	ug/L
	PAL	5	5	70
	PAL Reference	MCL	MCL	MCL
Sample ID:	**Date:**			
DP67/GW02	4/27/2016	3	3 U	3
DP68/GW01	4/27/2016	**5.2**	3 U	5.2
DP68/GW02	4/27/2016	4.2	3 U	4.2
DP69/GW01	4/28/2016	3 U	3 U	3 U
DP70/GW01	4/28/2016	3.6	3 U	3.6
DP70/GW02	4/26/2016	4.6	3 U	4.6
DP71/GW01	4/27/2016	3 U	3 U	3 U
DP72/GW01	4/27/2016	3 U	3 U	3 U
DP73/GW01	4/28/2016	**10.8**	3 U	10.8
DP74/GW01	4/28/2016	3 U	3 U	3 U
DP75/GW01	4/28/2016	3 U	3 U	3 U
DP76/GW01	4/28/2016	3 U	3 U	3 U
DP77/GW01	4/28/2016	Dry	Dry	Dry
DP78/GW01	5/24/2016	Dry	Dry	Dry
DP79/GW01	5/24/2016	3 U	3 U	3 U
DP79/GW02	5/24/2016	3 U	3 U	3 U
DP80/GW01	5/24/2016	3 U	3 U	3 U
DP80/GW02	5/24/2016	3 U	3 U	3 U
DP81/GW01	5/24/2016	3 U	3 U	3 U
DP81/GW02	5/24/2016	3 U	3 U	3 U
DP82/GW01	5/24/2016	3 U	3 U	3 U
DP82/GW02	5/24/2016	3 U	3 U	3 U
DP83/GW01	5/24/2016	3 U	3 U	3 U
DP83/GW02	5/24/2016	3 U	3 U	3 U
DP84/GW01	5/24/2016	3 U	3 U	3 U
DP84/GW02	5/24/2016	3 U	3 U	3 U

Notes:

Bold, shaded indicates action limit exceedence.

J = Estimated value

U = Compound was not detected

MCL = Maximum Contaminant Level (USEPA)

PAL = Project Action Level

ug/L = micrograms per Liter

USEPA = United States Environmental Protection Agency

ND = not detected

Table 4-7
Groundwater Field Parameter Measurements
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Fort Riley, Kansas

	Parameter:	pH	Temperature	Conductivity	ORP	DO	Fe	Depth to Water
	Units		°C	mS/cm	mV	mg/L	mg/L	bgs
	Geochemical Screening Values:	5 < pH < 9	>20	--	<50	<0.5	>1 mg/L	--
Sample ID:	**Date:**							
DP01-GW01	**13-Apr-16**	7.13	18.67	1.153	-32.1	0.53	Limit	50.2
DP02-GW01	**14-Apr-16**	6.61	20.03	1.15	-115	0.22	Limit	50
DP03-GW01	**19-Apr-16**	6.62	18.26	1.287	-7.7	0.4	Limit	51.6
DP06-GW01	**18-Apr-16**	6.34	16.14	1.291	-16.9	0.32	Limit	52.8
DP07-GW01	**20-Apr-16**	6.57	16.4	1.256	5.1	0.88	Limit	51.3
DP08-GW01	**18-Apr-16**	7.05	17.02	1.268	-93.9	0.211	Limit	51.8
DP09-GW01	**15-Apr-16**	6.53	20.09	1.22	-25.4	0.29	Limit	51.4
DP10-GW01	**11-Apr-16**	6.92	18.78	1.183	-47.1	0.72	Limit	49.9
DP11-GW01	**12-Apr-16**	7.08	17.43	1.13	8	2.4	Limit	50.2
DP12-GW01	**12-Apr-16**	7.28	17.19	0.293	0.6	0.28	Limit	50.3
DP14-GW01	**12-Apr-16**	7.07	20.57	1.258	20.9	3.81	Limit	55.2
DP15-GW01	**12-Apr-16**	7.11	19.38	1.212	-5	0.26	Limit	51.2
DP17-GW01	**13-Apr-16**	6.61	19.49	1.223	27.2	0.92	Limit	51.5
DP18-GW01	**12-Apr-16**	7.1	20.59	1.238	-86.9	0.7	Limit	50.2
DP19-GW01	**13-Apr-16**	6.39	20.71	1.228	-8.8	0.25	Limit	50
DP20-GW01	**13-Apr-16**	6.87	21.29	1.408	11.6	0.93	Limit	50
DP21-GW01	**13-Apr-16**	6.98	21.36	1.351	-55.1	1.86	Limit	48.3
DP22-GW01	**14-Apr-16**	6.85	19.6	1.29	-13.2	0.83	Limit	45.4
DP23-GW01	**22-Apr-16**	6.81	17.25	1.299	-88.7	0.71	Limit	39.2
DP24-GW01	**14-Apr-16**	6.77	14.63	0.18	-62.5	1.12	Limit	41.1
DP25-GW01	**13-Apr-16**	6.98	21.56	1.267	-29.3	0.58	Limit	43.8
DP26-GW01	**15-Apr-16**	6.7	21.62	1.26	-76.3	0.83	Limit	48
DP27-GW01	**22-Apr-16**	6.86	18.05	1.397	-18	0.73	Limit	50.9
DP28-GW01	**21-Apr-16**	6.86	21.16	1.598	-109.2	0.23	Limit	32.6
DP29-GW01	**19-Apr-16**	6.65	20.18	1.99	-54.8	0.2	Limit	36.9
DP30-GW01	**15-Apr-16**	7.42	21.92	1.36	30.3	1.27	Limit	41.8
DP31-GW01	**21-Apr-16**	6.89	22.1	1.53	8.9	0.19	Limit	45
DP32-GW01	**21-Apr-16**	6.89	19.82	1.962	-78.9	0.27	Limit	27.7
DP33-GW01	**19-Apr-16**	6.82	20.8	2.113	-40.1	0.32	Limit	36.3
DP34-GW01	**21-Apr-16**	6.69	18.53	1.586	-21.2	0.26	Limit	37.6
DP35-GW01	**21-Apr-16**	NA	NA	NA	NA	NA	Limit	12.9
DP36-GW01	**19-Apr-16**	6.67	20.02	3.677	40.3	3.61	Limit	14.8
DP37-GW01	**20-Apr-16**	6.92	20.59	2.059	38.7	3.47	Limit	33.2
DP38-GW01	**21-Apr-16**	6.66	17.77	1.468	-41.7	0.41	Limit	34.3
DP39-GW01	**22-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP40-GW01	**19-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP41-GW01	**21-Apr-16**	6.64	15.96	1.549	-144.2	0.3	Limit	23.4
DP42-GW01	**25-Apr-16**	6.81	18.82	1.959	49.7	0.87	Limit	25.2
DP43-GW01	**22-Apr-16**	6.52	14.01	2.513	-90.9	0.44	Limit	23.7
DP43-GW02	**22-Apr-16**	6.36	14.55	2.208	-34.2	0.8	Limit	23.7
DP44-GW01	**21-Apr-16**	6.31	16.66	2.55	-49	0.47	Limit	25.9
DP44-GW02	**21-Apr-16**	6.2	15.88	2.289	-30.1	1.17	Limit	25.9
DP45-GW01	**20-Apr-16**	6.8	18.13	2.915	-4.6	0.68	Limit	24.8
DP45-GW02	**20-Apr-16**	6.54	16.53	2.62	-22	0.61	Limit	24.8
DP46-GW01	**20-Apr-16**	6.76	18.16	3.109	-85	0.75	Limit	26.5

Table 4-7
Groundwater Field Parameter Measurements
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	Parameter:	pH	Temperature	Conductivity	ORP	DO	Fe	Depth to Water
	Units		°C	mS/cm	mV	mg/L	mg/L	bgs
	Geochemical Screening Values:	5 < pH < 9	>20	--	<50	<0.5	>1 mg/L	--
Sample ID:	**Date:**							
DP46-GW02	**20-Apr-16**	6.67	18.09	2.742	-107.7	0.45	Limit	26.5
DP47-GW01	**21-Apr-16**	6.42	17.8	4.169	-114.3	0.79	Limit	25.2
DP47-GW02	**21-Apr-16**	6.18	17.15	2.171	-129.7	0.18	Limit	25.2
DP49-GW01	**26-Apr-16**	NA	NA	NA	NA	NA	Limit	56.7
DP50-GW01	**26-Apr-16**	7.7	24.54	1.492	-3.9	0.5	Limit	49
DP51-GW01	**14-Apr-16**	6.91	21.84	1.13	-119.6	0.28	Limit	52.9
DP52-GW01	**14-Apr-16**	6.98	21.51	1.2	21.7	1.3	Limit	53
DP53-GW01	**14-Apr-16**	6.74	21.45	NA	-83.9	0.14	Limit	49.1
DP54-GW01	**25-Apr-16**	6.86	23.82	2.224	-46	0.11	Limit	36.8
DP55-GW01	**25-Apr-16**	6.59	23.82	1.835	-26.6	0.21	Limit	40.3
DP56-GW01	**25-Apr-16**	6.91	20.97	4.25	44.4	2.25	Limit	25.5
DP57-GW01	**25-Apr-16**	NA	NA	NA	NA	NA	Limit	31.9
DP58-GW01	**25-Apr-16**	6.84	22.39	2.201	-6.2	0.79	Limit	46.9
DP59-GW01	**25-Apr-16**	6.7	22.74	1.907	16.9	0.25	Limit	40.6
DP60-GW01	**26-Apr-16**	6.87	19.51	1.577	39.6	0.44	Limit	36.8
DP61-GW01	**25-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP62-GW01	**27-Apr-15**	7.04	17.43	1.229	-63.2	0.42	Limit	36
DP63-GW01	**27-Apr-16**	NA	NA	NA	NA	NA	Limit	15.8
DP64-GW01	**26-Apr-16**	NA	NA	NA	NA	NA	Limit	37.2
DP65-GW01	**26-Apr-16**	6.75	15.54	1.52	-3	0.25	Limit	29.7
DP66-GW01	**26-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP67-GW01	**27-Apr-16**	6.65	16.91	3.55	-121.3	0.39	Limit	24
DP67-GW02	**27-Apr-16**	6.46	16.04	3.204	-124.2	0.42	Limit	24
DP68-GW01	**27-Apr-16**	6.48	15.49	2.712	-48.6	0.38	Limit	25.5
DP68-GW02	**27-Apr-16**	6.36	15.23	2.616	-96.2	0.18	Limit	25.5
DP69-GW01	**27-Apr-16**	6.64	15.01	2.489	-179.2	0.17	Limit	32.6
DP70-GW01	**28-Apr-16**	6.26	12.49	2.171	-21.6	0.59	Limit	26.5
DP70-GW02	**28-Apr-16**	6.27	13.27	2.14	-29.5	0.24	Limit	26.5
DP71-GW01	**26-Apr-16**	6.64	23.37	1.484	24.4	0.2	Limit	49
DP72-GW01	**27-Apr-16**	6.9	18.53	1.315	40.8	0.47	Limit	53.8
DP73-GW01	**27-Apr-16**	6.84	19.29	1.329	-106.9	0.25	Limit	50.3
DP74-GW01	**28-Apr-16**	NA	NA	NA	NA	NA	Limit	25.4
DP75-GW01	**28-Apr-16**	NA	NA	NA	NA	NA	Limit	29.7
DP76-GW01	**28-Apr-16**	6.88	19.47	1.872	32.7	0.29	Limit	30.2
DP77-GW01	**28-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP78-GW01	**28-Apr-16**	Dry	Dry	Dry	Dry	Dry	Limit	Dry
DP79-GW01	**24-May-16**	6.9	18.91	2.972	-121.4	0.29	Limit	23.3
DP79-GW02	**24-May-16**	6.88	16.71	2.771	-128.1	0.45	Limit	23.3
DP80-GW01	**24-May-16**	6.8	16.09	2.799	-121.4	0.47	Limit	23
DP80-GW02	**24-May-16**	6.78	16.21	2.834	-131.4	0.42	Limit	23
DP81-GW01	**24-May-16**	6.75	16.04	2.541	-120.1	0.46	Limit	23.2
DP81-GW02	**24-May-16**	6.73	16.14	2.494	-119.1	0.49	Limit	23.2
DP82-GW01	**24-May-16**	6.77	16.21	2.667	-127.7	0.4	Limit	23.3
DP82-GW02	**24-May-16**	6.74	16.12	2.701	-124.1	0.85	Limit	23.3
DP83-GW01	**24-May-16**	6.66	16.01	2.777	-124.1	0.42	Limit	22.9

Table 4-7
Groundwater Field Parameter Measurements
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	Parameter:	pH	Temperature	Conductivity	ORP	DO	Fe	Depth to Water
	Units		°C	mS/cm	mV	mg/L	mg/L	bgs
	Geochemical Screening Values:	5 < pH < 9	>20	--	<50	<0.5	>1 mg/L	--
Sample ID:	**Date:**							
DP83-GW02	**24-May-16**	6.69	15.99	2.79	-130.4	0.45	Limit	22.9
DP84-GW01	**24-May-16**	6.72	16.26	2.774	-137.3	0.37	Limit	22.8
DP84-GW02	**24-May-16**	6.74	16.27	2.699	-129.8	0.39	Limit	22.8

Reference: EPA, 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. Sept.1998. EPA 600/R-98/128

Notes:

DO = dissolved oxygen
ID = Identification
mg/L = milligrams per liter
mS/cm = milli Siemens per centimeter
mV = millivolt
NA = Insufficient water/only analytical sample collected
ORP = oxidation-reduction potential
Fe = ferrous iron

Table 4-8
Off-site Laboratory Groundwater Sample Analytical Results - Detections Only
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Fort Riley, Kansas

	Analyte	Acetone	Benzene	Chloroform	cis-1,2-Dichloroethene	Ethylbenzene	Naphthalene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene
	Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	PAL	45500	5	80	70	700	2.11	5	1000	100	5
	PAL Reference	RSK	MCL	MCL	MCL	MCL	RSK	MCL	MCL	MCL	MCL
Sample ID:	**Date:**										
354-DP07-GW01	4/20/2016	2 U	0.62 U	1.4 J	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
354-DP07-GW11	4/20/2016	2 U	0.62 U	1.3 J	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
354-DP18-GW01	4/12/2016	1 U	0.22 J	1.9	0.74 J	0.68 J	0.5 U	**9**	0.77 J	0.5 U	0.46 J
354-DP19-GW01	4/13/2016	1 U	0.5 U	2.1	0.5 U	0.5 U	0.5 U	0.5 U	0.54 J	0.5 U	0.5 U
354-DP21-GW01	4/13/2016	1 U	0.5 U	1.9	**78**	0.5 U	0.5 U	**170**	0.5 U	1	**16**
354-DP29-GW01	4/19/2016	3.4	0.62 U	0.62 UJ	0.62 U	62 U	0.62 U	**11**	0.62 U	0.62 U	0.62 U
354-DP41-GW01	4/21/2016	14 J	**5.2 J**	0.62 UJ	9.7 J	10 J	**18 J**	0.62 U	0.62 U	0.62 U	0.62 U
354-DP42-GW01	4/25/2016	2 U	0.21 J	1.4 J	0.64 J	0.62 U	1.7	**28**	0.31 J	0.62 U	0.96 J
354-DP67-GW01	4/27/2016	2 U	0.62 U	0.62 UJ	2.4	0.33 J	0.62 U	0.62 U	0.36 J	0.62 U	0.93 J
354-DP68-GW01	4/27/2016	2 U	0.62 U	0.62 UJ	0.62 U	0.77 J	0.62 U	2.7	0.69 J	0.62 U	0.6 J
354-DP82-GW01	5/24/2016	2.5 U	0.62 U	0.62 UJ	3.7	0.62 U	0.62 U	0.48 J	0.27 J	0.62 U	0.81 J
354-DP82-GW11	5/24/2016	2.5 U	0.62 U	0.62 UJ	3.9	0.62 U	0.62 U	0.42 J	0.26 J	0.62 U	0.76 J
354-DP84-GW01	5/24/2016	2.5 U	0.62 U	0.62 UJ	5.1	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U

Notes:

Bold, shaded indicates action limit exceedence

J = Estimated value

UJ = Compound was not detected/estimated value

U = Compound was not detected

NA = Not available

PAL = Project Action Level

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR=1E-05 (September, 2015)

MCL=EPA Maximum Contaminant Level Standards

ND = not detected

Table 4-9
Comparison of Field GC and Laboratory Results - Groundwater
354 Area PDI Report
Fort Riley, Kansas

Sample ID:	Date Sampled	On-site GC Analysis (EPS) results in ppb			Off-site Confirmation Analysis (ALS) results in ug/L (water)		
		cis-,1,2-DCE	TCE	PCE	cis-,1,2-DCE	TCE	PCE
354-DP18-GW01	4/12/2016	3 U	3 U	9.6	0.74 J	0.46 J	9
354-DP19-GW01	4/13/2016	3 U	3 U	3 U	0.5 U	0.5 U	0.5 U
354-DP21-GW01	4/13/2016	47.1	10.4	80.6	78	16	170
354-DP29-GW01	4/19/2016	3 U	3 U	6.9	0.62 U	0.62 U	11
354-DP07-GW01	4/20/2016	3 U	3 U	3.6	0.62 U	0.62 U	0.62 U
354-DP41-GW01	4/21/2016	N/A	12 U	12 U	9.7 J	0.62 U	0.62 U
354-DP42-GW01	4/25/2016	3 U	3 U	16.2	0.64 J	0.96 J	28
354-DP67-GW01	4/27/2016	3 U	3 U	3 U	2.4	0.93 J	0.62 U
354-DP68-GW01	4/27/2016	3 U	3 U	5.2	0.62 U	0.6 J	2.7
354-DP82-GW01	5/24/2016	2	2 U	2 U	3.9	0.81 J	0.48 J
354-DP84-GW01	5/24/2016	3.7	2 U	2 U	5.1	0.62 U	0.62 U

cis-1,2-DCE = cis-1,2-Dichloroethene
EPS = Environmental Priority Services, Inc.
GC = Gas Chromatograph
J = Estimated value.
N/A = Interference Noted no result reported.
ppb = parts per billion
PCE = Tetrachloroethene

R = Data was rejected
U = Compound was not detected. Value is the reporting limit.
µg/L = micrograms per liter
TCE = Trichloroethene

Table 4-10

Monitoring Well Sample Analytical Results (Detections only)

354 Area PDI Report

Fort Riley, Kansas

				354-01-27				354-01-30C		354-99-09	
				5/11/2016 GW01	5/11/2016 GW11	8/18/2016 GW02	8/18/2016 GW22	5/10/2016 GW01	8/182016 GW02	5/11/2016 GW01	8/18/2016 GW02
Analyte	**Units**	**PAL**	**PAL Reference**		Duplicate		Duplicate				
Volatile Organic Compounds											
Acetone	µg/L	45500	RSK	2.5 U	2.5 U	18	5.8	2.5 U	13	2.5 U	1.0 U
Benzene	µg/L	5	MCL	0.62 U	0.62 U	0.50 U	0.50 U	0.62 U	0.50 U	0.62 U	0.50 U
Chloroform	µg/L	80	MCL	0.55 J	0.58 J	0.50 U	0.50 U	0.62 UJ	0.50 UJ	0.36 J	0.50 U
cis-1,2-Dichloroethene	µg/L	70	MCL	0.62 U	0.62 U	0.50 U	0.50 U	0.62 U	0.50 U	0.62 U	0.50 U
m,p-Xylene	µg/L	NA	NA	1.20 U	1.20 U	1.0 U	1.0 U	1.20 U	1.0 U	1.20 U	1.0 U
Tetrachloroethene	µg/L	5	MCL	**85**	**85**	**5.5**	**5.4**	0.62 U	0.50 U	**12**	**5.2**
Trichloroethene	µg/L	5	MCL	1.0	1.1	0.50 U	0.50 U	0.62 U	0.50 U	0.62 U	0.50 U
Metals											
Iron	mg/L	0.3	Secondary MCL	0.2 U	0.2 U	0.10 U	0.10 U	**1.09**	**1.30**	0.2 U	0.10 U
Manganese	mg/L	0.05	RSK	0.001 U	0.001 U	0.001 U	0.001 U	**1.52**	**1.56**	0.001 U	0.001 U
Natural Attenuation Parameters											
Ethane	µg/L	10	(1)	0.36 U	0.36 U	0.361 U	0.361 U	0.36 U	0.361 U	0.36 U	0.361 U
Methane	µg/L	>500	(1)	0.20 U	0.20 U	0.20 U	0.20 U	4.98	4.87	0.20 U	0.20 U
Alkalinity, Total (As CaCO3)	mg/L	>680 or 816	(2)	311.0	314.0	222.0	221.0	426.0	431.0	281.0	295.0
Chloride	mg/L	> 56 or 86	(3)	87.1	86.3	97.5	97.9	49.2	51.8	353.0	585.0
Nitrate/Nitrite (as N)	mg/L	10	MCL	8.420	8.200	3.980 J	4.160 J	0.048 J	0.50 UJ	**11.900**	**12.000** J
Nitrogen, Nitrate (As N)	mg/L	10	MCL	8.42	8.20	2.20 J	2.20 J	0.05 J	0.14	**11.90**	**10.50** J
Nitrogen, Nitrite (As N)	mg/L	1	MCL	0.05 U	0.05 U	0.05 UJ	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 UJ
Sulfate	mg/L	<20	(1)	65.40	64.00	12.60	12.60	115.00	112.00	70.70	62.50
Sulfide	mg/L	>1	(1)	0.03 U	25 U	0.025 U	0.025 U	0.03 U	0.025 U	25 U	25 U
Organic Carbon, Total	mg/L	>20	(1)	1.13	1.12	1.20	1.13	1.79	1.72	1.05	1.43

Notes:

Bold, shaded indicates action limit exceedance

J = Estimated value

UJ = Compound was not detected/estimated value

U = Compound was not detected

NA = not available

PAL = Project Action Level

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR=1E-05 (September, 2015)

MCL=EPA Maximum Contaminant Level Standards

*Results are unvalidated

ND = not detected

(1) = From USEPA 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.

(2) = These values represent two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for alkalinity of groundwater from Kansas River alluvial deposits is 340 mg/L, with a range of 170-470 mg/L (Fader, 1974). Average values for alkalinity of groundwater from the terrace aquifer is 408 mg/L, with a range of 376-454 mg/L (LBA, 1996). Therefore, twice the average values are 680 mg/L (alluvial) and 816 mg/L (terrace).

(3) = These values represent two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for chloride of groundwater from Kansas River alluvial deposits is 28 mg/L, with a range of 3.0-84 mg/L (Fader, 1974). Average values for chloride of groundwater from the terrace aquifer is 43 mg/L, with a range of 6-130 mg/L (LBA, 1996). Therefore, twice the average values are 56 mg/L (alluvial) and 86 mg/L (terrace).

Table 4-10
Monitoring Well Sample Analytical Results (Detections only)
354 Area PDI Report
Fort Riley, Kansas

				354-99-12C		354-99-13C		TSO292-01		TSO292-02	
				5/11/2016 GW01	8/18/2016 GW02	5/11/2016 GW01	8/18/2016 GW02	5/11/2016 GW01	8/19/2016 GW02	5/11/2016 GW01	8/182016 GW02
Analyte	**Units**	**PAL**	**PAL Reference**								
Volatile Organic Compounds											
Acetone	µg/L	45500	RSK	2.5 U	15	2.5 U	10	2.5 U	1.0 U	2.5 U	8
Benzene	µg/L	5	MCL	0.62 U	0.50 U	0.62 U	0.50 U	0.62 U	0.50 U	0.53 J	0.50 U
Chloroform	µg/L	80	MCL	0.62 UJ	0.50 U	0.62 UJ	0.50 U	0.62 J	0.50 U	1.4 J	0.50 U
cis-1,2-Dichloroethene	µg/L	70	MCL	4.10	3.9	0.62 U	0.50 U	0.79 J	0.64 J	0.90 J	0.50 U
m,p-Xylene	µg/L	NA	NA	1.20 U	1.0 U	1.20 U	1.0 U	1.20 U	1.0 U	0.57 J	1.0 U
Tetrachloroethene	µg/L	5	MCL	0.62 U	0.50 U	0.62 U	0.50 U	**39**	**20**	0.62 U	0.50 U
Trichloroethene	µg/L	5	MCL	0.75 J	0.74 J	0.62 U	0.50 U	3.2	2.1	0.62 U	0.50 U
Metals											
Iron	mg/L	0.3	Secondary MCL	**9.34**	**8.24**	**8.40**	**8.87**	0.2 U	0.0271 J	**13.10**	**6.45**
Manganese	mg/L	0.05	RSK	**0.53**	**0.484**	**1.37**	**1.38**	0.007	0.0388	**0.48**	**0.272**
Natural Attenuation Parameters											
Ethane	µg/L	10	(1)	0.36 U	0.361 U	0.36 U	0.361 U	0.36 U	0.361 U	1.93	1.10
Methane	µg/L	>500	(1)	0.20 U	2.31	0.2 U	54.70	4.01	1.70	134.00	50.10
Alkalinity, Total (As CaCO3)	mg/L	>680 or 816	(2)	405.0	416.0	358.0	411.0	323.0	327.0	507.0	364.0
Chloride	mg/L	> 56 or 86	(3)	471.0	485.0	72.4	54.8	310.0	241.0	155.0	30.6
Nitrate/Nitrite (as N)	mg/L	10	MCL	0.036 J	0.50 UJ	0.117	0.50 UJ	9.420	7.350 J	0.048 J	0.05 UJ
Nitrogen, Nitrate (As N)	mg/L	10	MCL	0.04 J	0.14 J	0.12	0.14	9.42	6.67	0.05 J	0.13 J
Nitrogen, Nitrite (As N)	mg/L	1	MCL	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.26	0.05 U	0.05 UJ
Sulfate	mg/L	<20	(1)	169.00	171.00	130.00	122.00	102.00	71.40	8.01	0.78 J
Sulfide	mg/L	>1	(1)	0.03 U	25 U	0.02 J	0.07	25 U	0.025 U	0.11	0.11
Organic Carbon, Total	mg/L	>20	(1)	1.55	1.75	1.90	1.91	1.28	1.98	3.26	2.40

Notes:

Bold, shaded indicates action limit exceedance

J = Estimated value

UJ = Compound was not detected/estimated value

U = Compound was not detected

NA = not available

PAL = Project Action Level

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR=1E-05 (September, 2015)

MCL=EPA Maximum Contaminant Level Standards

*Results are unvalidated

ND = not detected

(1) = From USEPA 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.

(2) = These values represent two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for alkalinity of groundwater from Kansas River alluvial deposits is 340 mg/L, with a range of 170-470 mg/L (Fader, 1974). Average values for alkalinity of groundwater from the terrace aquifer is 408 mg/L, with a range of 376-454 mg/L (LBA, 1996). Therefore, twice the average values are 680 mg/L (alluvial) and 816 mg/L (terrace).

(3) = These values represent two times the background value as per natural attenuation protocol (USEPA, 1998). Average values for chloride of groundwater from Kansas River alluvial deposits is 28 mg/L, with a range of 3.0-84 mg/L (Fader, 1974). Average values for chloride of groundwater from the terrace aquifer is 43 mg/L, with a range of 6-130 mg/L (LBA, 1996). Therefore, twice the average values are 56 mg/L (alluvial) and 86 mg/L (terrace).

Table 4-11
Monitoring Well Microbial Presence and Volatile Fatty Acids Results
354 Area PDI Report
Fort Riley, Kansas

			Sample ID:	354-01-30C-GW01	TS0292-01-GW01	TS0292-02-GW01	354-99-09-GW01	354-01-27-GW01	354-99-13C-GW01	354-99-12C-GW01
			Sample Date:	5/10/2016	5/11/2016	5/11/2016	5/11/2016	5/11/2016	5/11/2016	5/11/2016
Analyte	**Units**	**PAL**	**PAL Reference**							
Microbial Presence										
Dehalococcoides	cells/mL	NA	NA	3.57E+01	1.98E+01	8.59E+01	5.00E-01 U	5.00E-01 U	1.97E+02	1.50E+02
BAV1 Vinyl Chloride Reductase	cells/mL	NA	NA	5.00E-01 J	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U
tceA Reductase	cells/mL	NA	NA	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U
Vinyl Chloride Reductase	cells/mL	NA	NA	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U	5.00E-01 U
Volatile Fatty Acids										
Acetic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Butyric Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Formic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Hexanoic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
i-Hexanoic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
i-Pentanoic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Lactic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Pentanoic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Propionic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Pyruvic Acid	mg/L	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U

Notes:

cells/L = cells per liter
J = Estimated value
mg/L = milligrams per liter
NA = not available
PAL = Project Action Level
U = Non-detect

Table 4-12
Monitoring Wells - Groundwater Field Parameter Measurements
354 Area PDI Report
Fort Riley, Kansas

Sample ID:		354-01-30C		TS0292-01		TS0292-02		354-99-09		354-01-27		354-99-12C		354-99-13C	
Date Sampled:		10-May-16	18-Aug-16	11-May-16	19-Aug-16	11-May-16	18-Aug-16	11-May-16	18-Aug-16	11-May-16	18-Aug-16	11-May-16	18-Aug-16	11-May-16	18-Aug-16
Comment:		clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear
Parameter	**Units**														
Field Measurements															
pH		7.41	7.17	6.6	6.84	6.83	7.07	6.09	6.88	6.88	6.98	6.8	6.95	7.11	7.32
Temperature	°C	15.23	15.06	16.37	17.52	14.82	20.74	15.19	18.02	17.64	21.82	14.06	15.92	14.43	15.18
Conductivity	mS/cm	0.886	0.749	5.186	1.239	3.867	0.587	5.036	1.777	2.999	0.596	6.631	1.689	3.049	0.766
Turbidity	NTU	23.3	8.71	7.09	7.64	6.3	1.07	11.1	2.01	6.56	11.19	26.4	0.54	12.1	3.19
ORP	mV	-8.1	-59.9	67.1	64.8	-81	-71.8	102.2	13.9	103.5	41.7	-53.4	-58.3	-94.9	-137.9
DO	mg/L	0.5	0.45	1.28	1.13	0.43	0.41	6.96	6.28	5.64	7.22	0.28	0.81	1.48	1.22
Ferrous Iron	mg/L	1.2	0.25	0.07	0.05	3.3	2.1	0.19	0.05	0.17	0.09	3.3	4.51	3.3	0.03
Depth to Water	ft TOC	13.7	12.4	25.03	24.75	BTOP	14.19	BTOP	BTOP	52.83	30.93	22.59	21	23.34	21.96

Notes:

DO = dissolved oxygen
ID = Identification
mg/L = milligrams per liter
mS/cm = milli Siemen per centimeter
mV = millivolt
NTU = Nephelometric Turbidity Unit
ORP = oxidation-reduction potential
BTOP = below top of pump

Figures

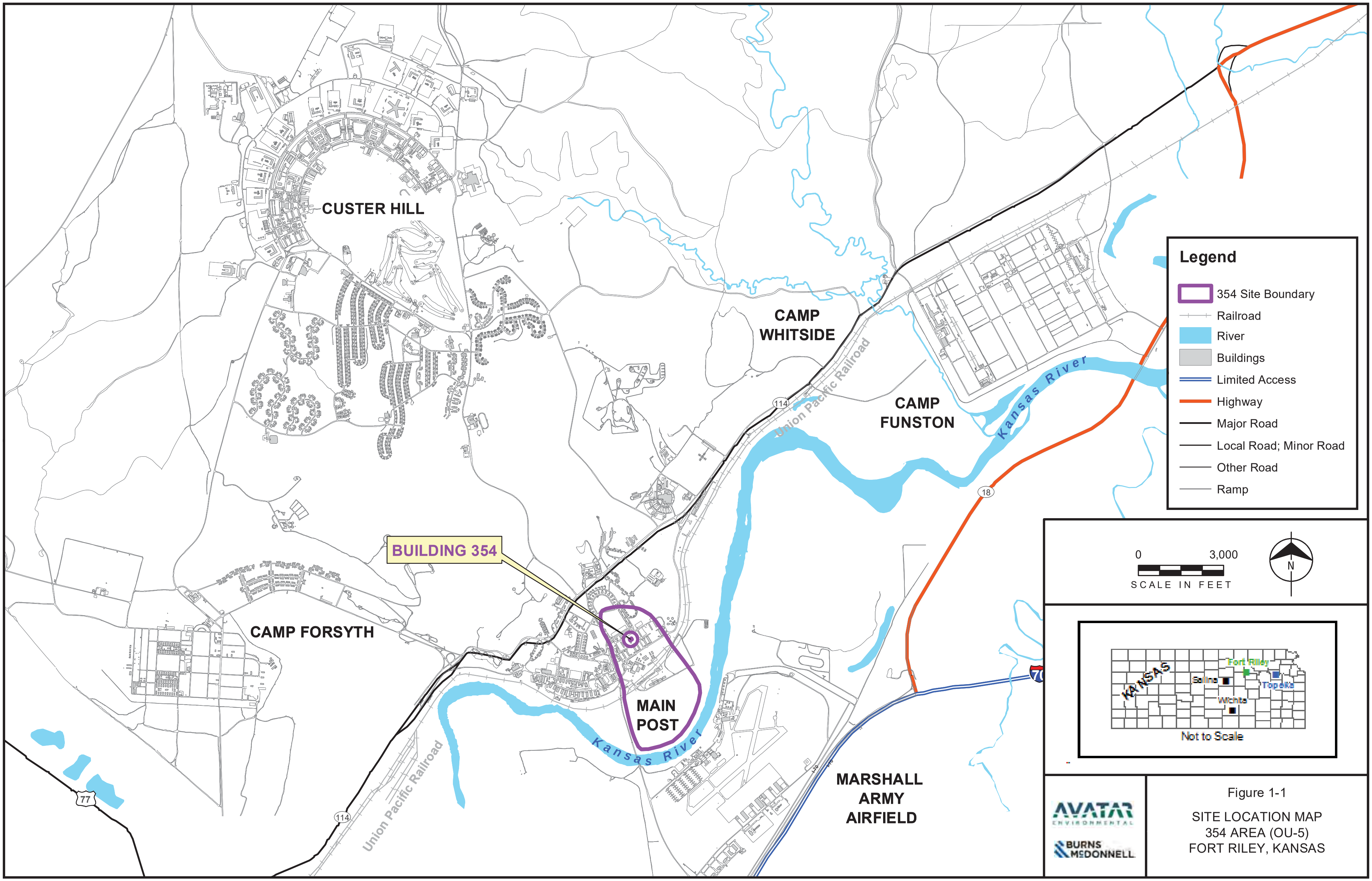


Figure 1-1

SITE LOCATION MAP
354 AREA (OU-5)
FORT RILEY, KANSAS

Legend

⊗	Monitoring Well
⊙	Groundwater Boring
- - -	Aquifer Boundaries
○	Former Building 354 Location

N

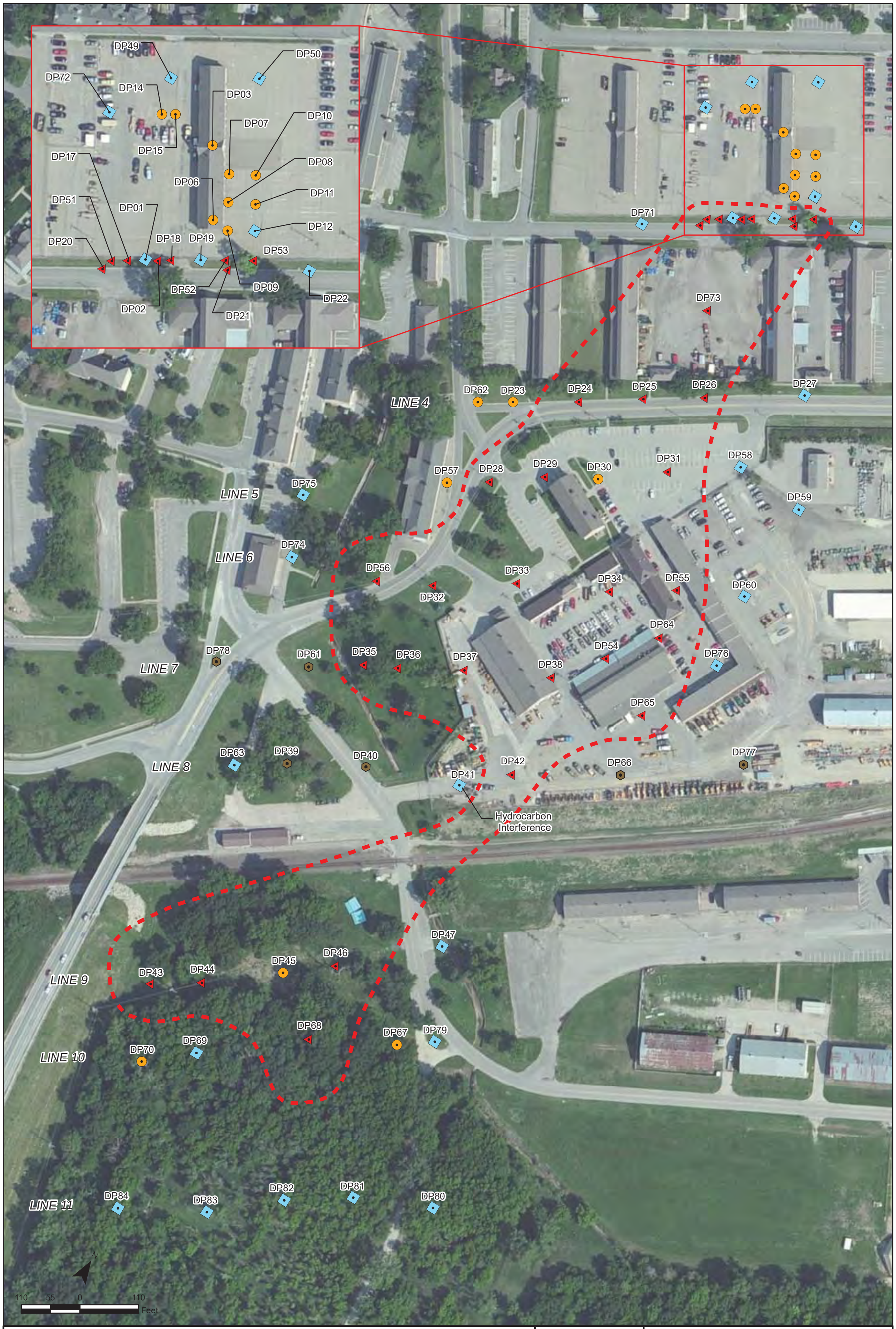
200 100 0 200
Feet

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 1-2

SITE DETAIL
354 AREA (OU-5)
FORT RILEY, KANSAS



Legend
- ⊙ Groundwater boring
- ● Dry
- ▣ Result is not detected
- ● Result detected below PAL
- ▲ Result exceeds PAL
- - - Approximate extent of PCE contamination in groundwater

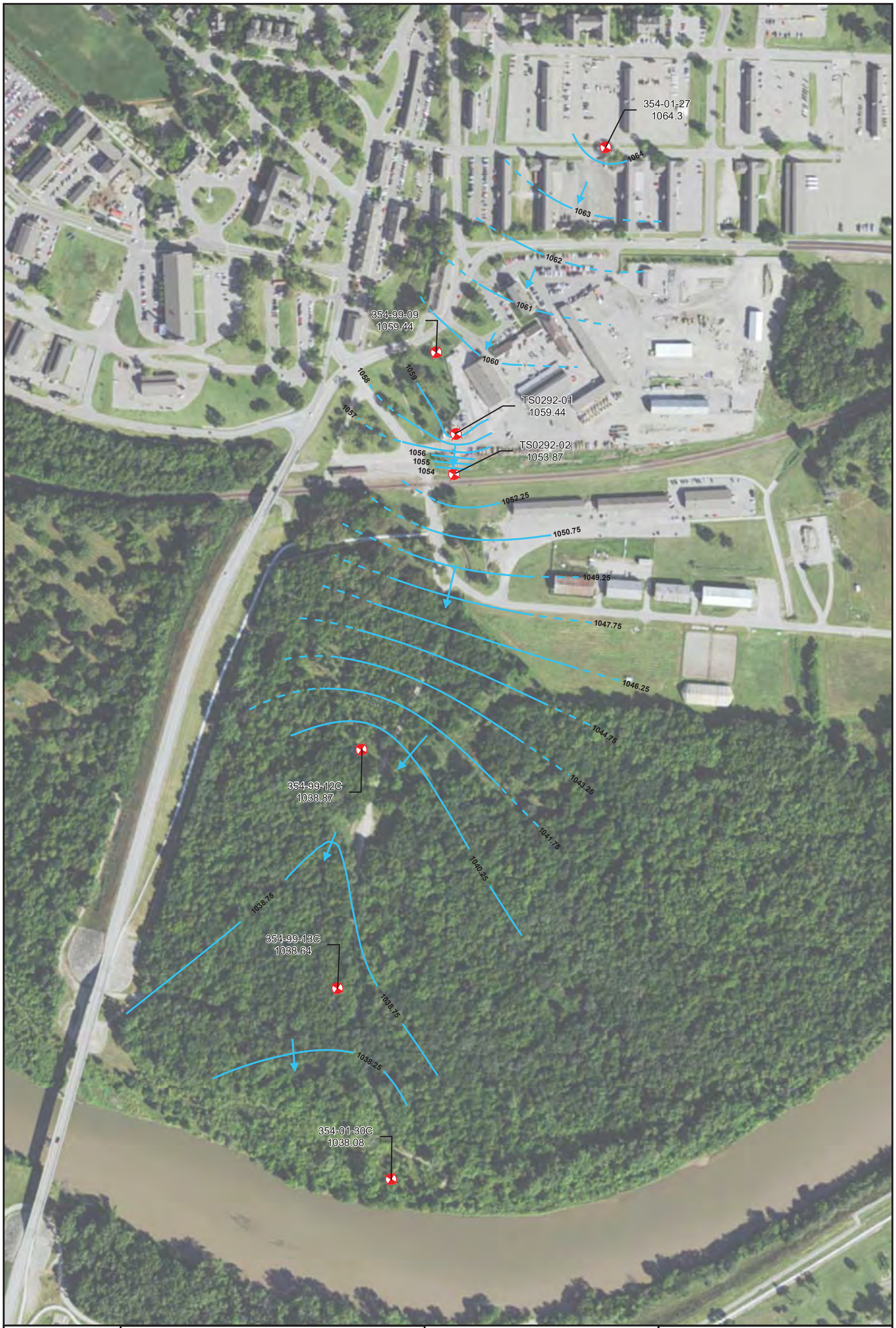
Analyte	Units	PAL	PAL Reference
PCE	ug/L	5	MCL
TCE	ug/L	5	MCL
cis-1,2 DCE	ug/L	70	MCL

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 2-1

DIRECT-PUSH GROUNDWATER
FIELD GC PCE RESULTS
354 AREA (OU-5)
FORT RILEY, KANSAS



Legend

- Monitoring Well
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Direction of Groundwater Flow
- 1038.08 Groundwater Elevation

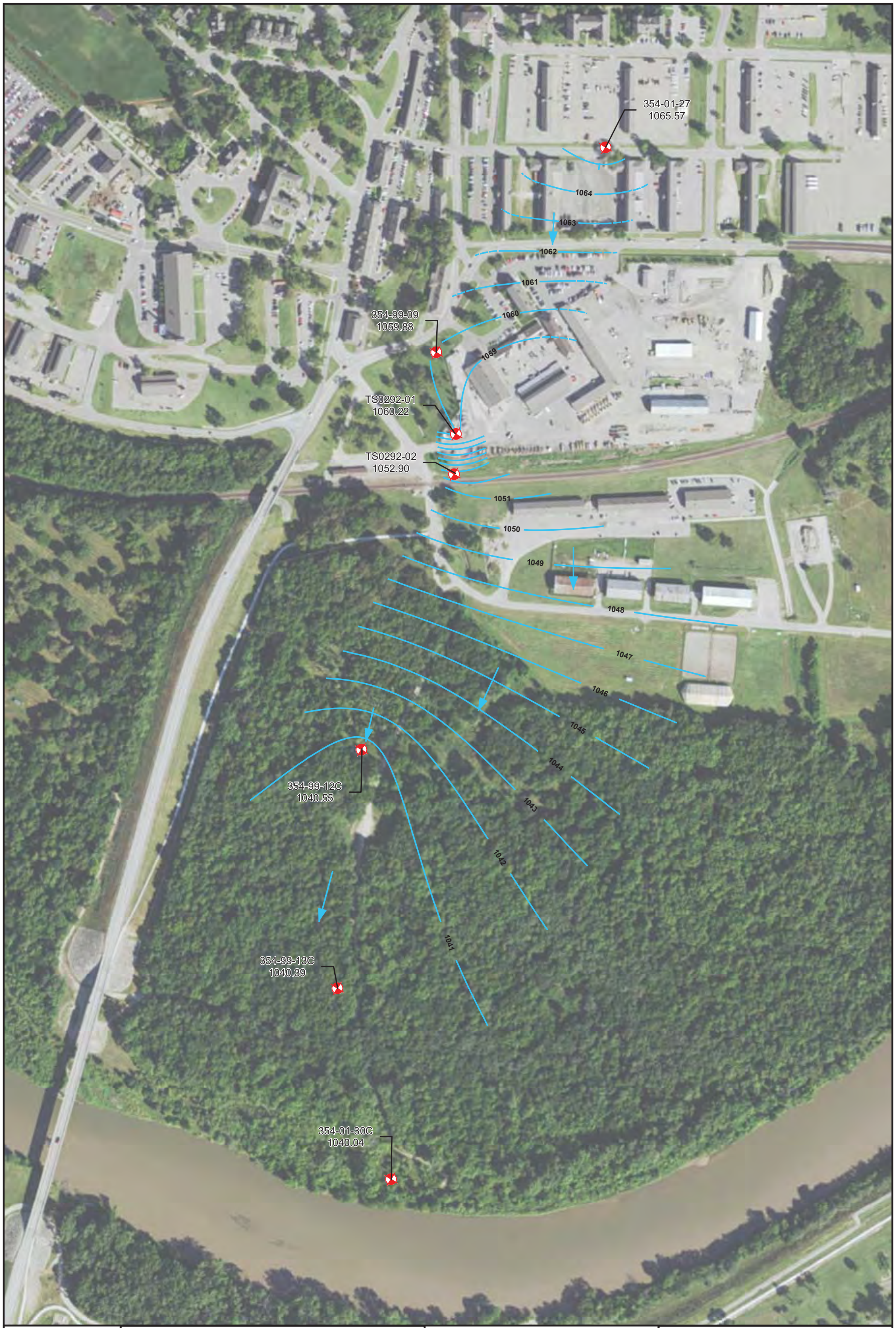
*All groundwater elevations are shown in feet above mean sea level.

N

320 160 0 320 Feet

Figure 3-1

MAY 2016
GROUNDWATER CONTOUR MAP
354 AREA (OU-5)
FORT RILEY, KANSAS



Legend

- ⊕ Monitoring Well
- — Groundwater Elevation Contour
- - - Inferred Groundwater Elevation Contour
- → Direction of Groundwater Flow
- 1065.57 Groundwater Elevation

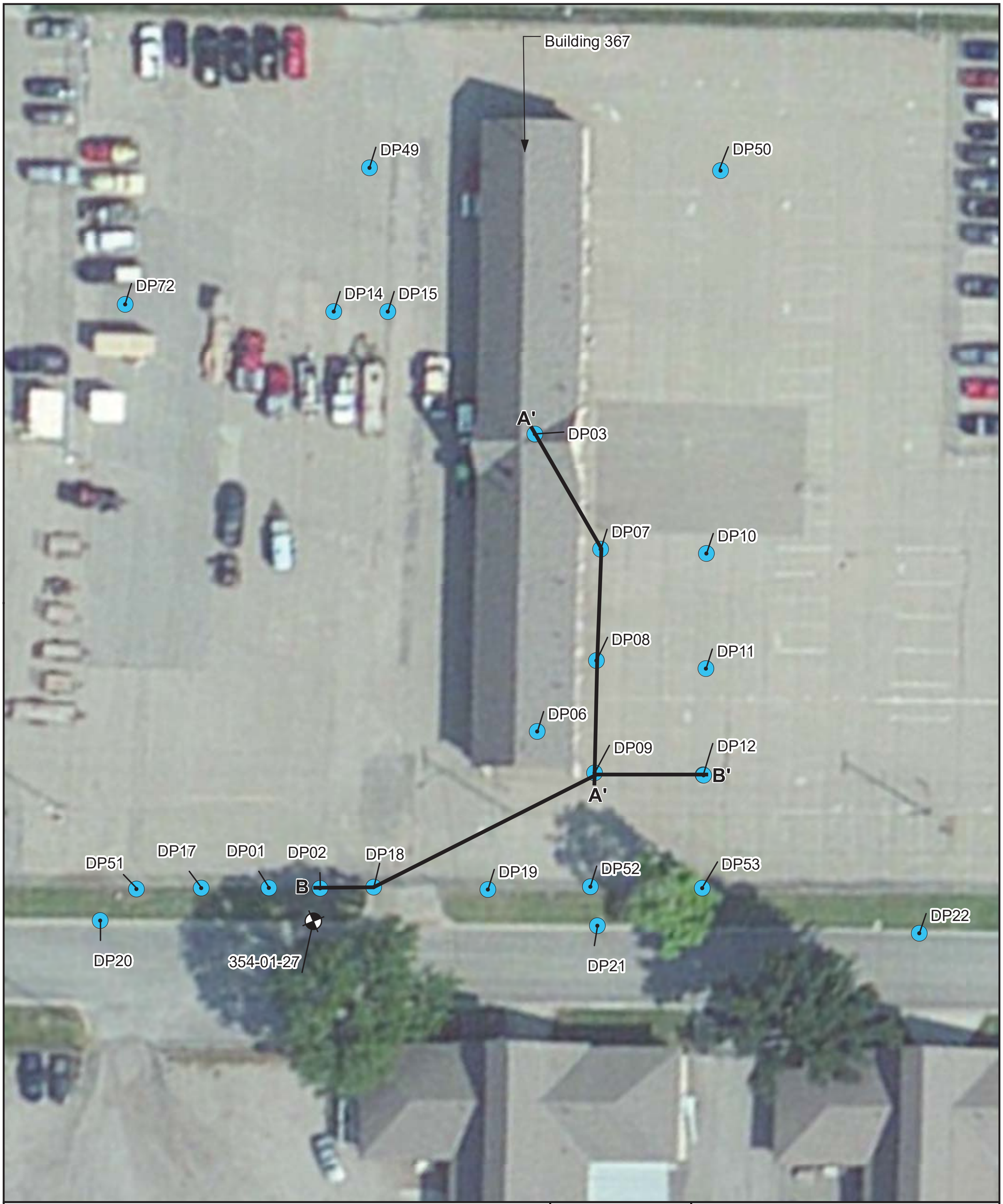
*All groundwater elevations are shown in feet above mean sea level.

N

320 160 0 320 Feet

Figure 3-2

AUGUST 2016
GROUNDWATER CONTOUR MAP
354 AREA (OU-5)
FORT RILEY, KANSAS



Legend

⊗ Monitoring Well

● Groundwater Boring

X —— X' Geologic Cross Sections

N

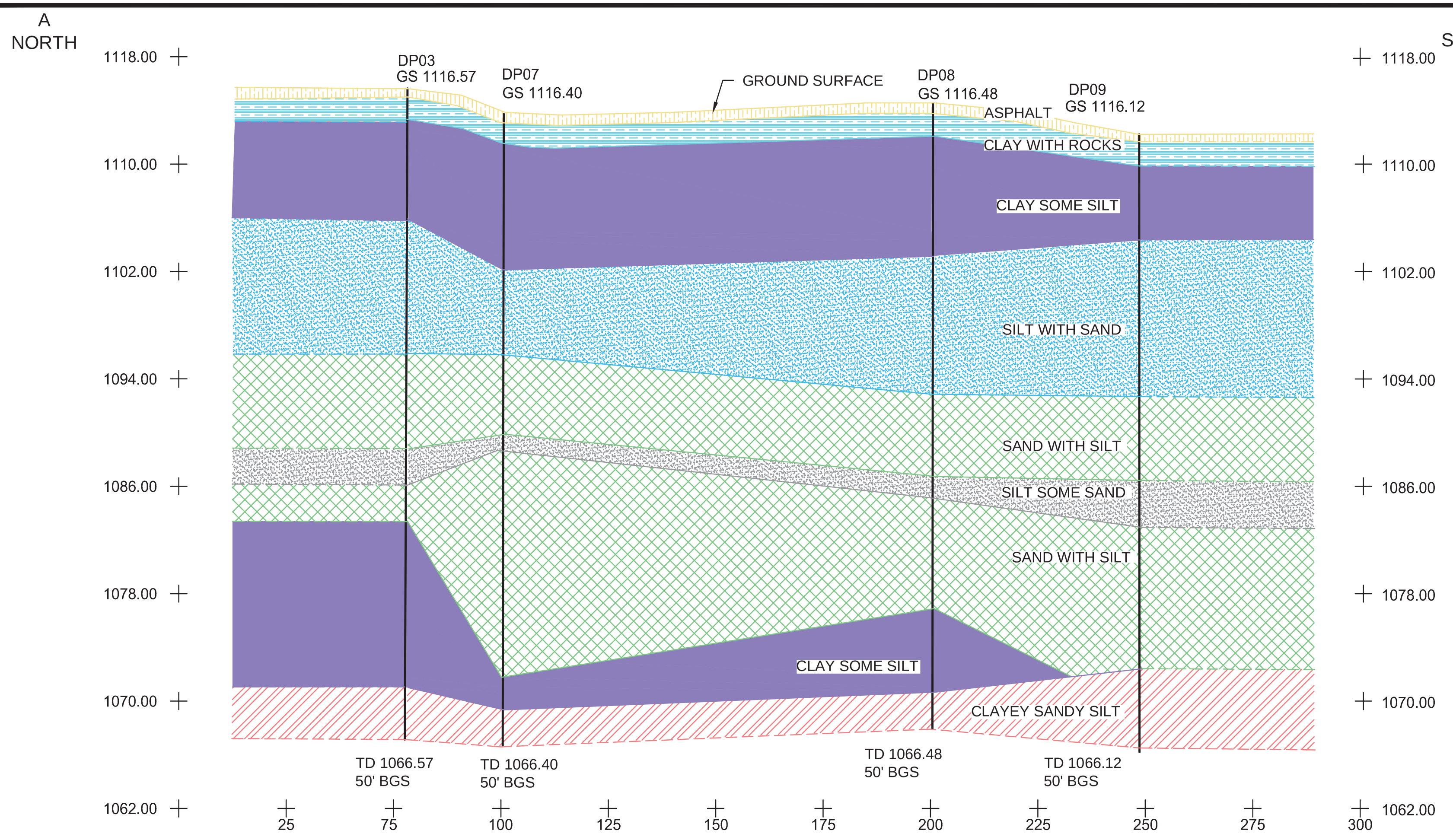
0 20 40 80 Feet

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 3-3

GEOLOGIC CROSS SECTION
354 AREA (OU-5)
FORT RILEY, KANSAS



LEGEND

—	DIRECT-PUSH BORING	■	SILT WITH SAND
BGS	BELOW GROUND SURFACE	▨	SAND WITH SILT
▥	ASPHALT	▧	CLAYEY SANDY SILT
▤	CLAY WITH ROCKS	GS	GROUND SURFACE
■	SAND SOME SILT	——	CONTACT INFERRED
■	CLAY SOME SILT		

NOTES:

1. ALL ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

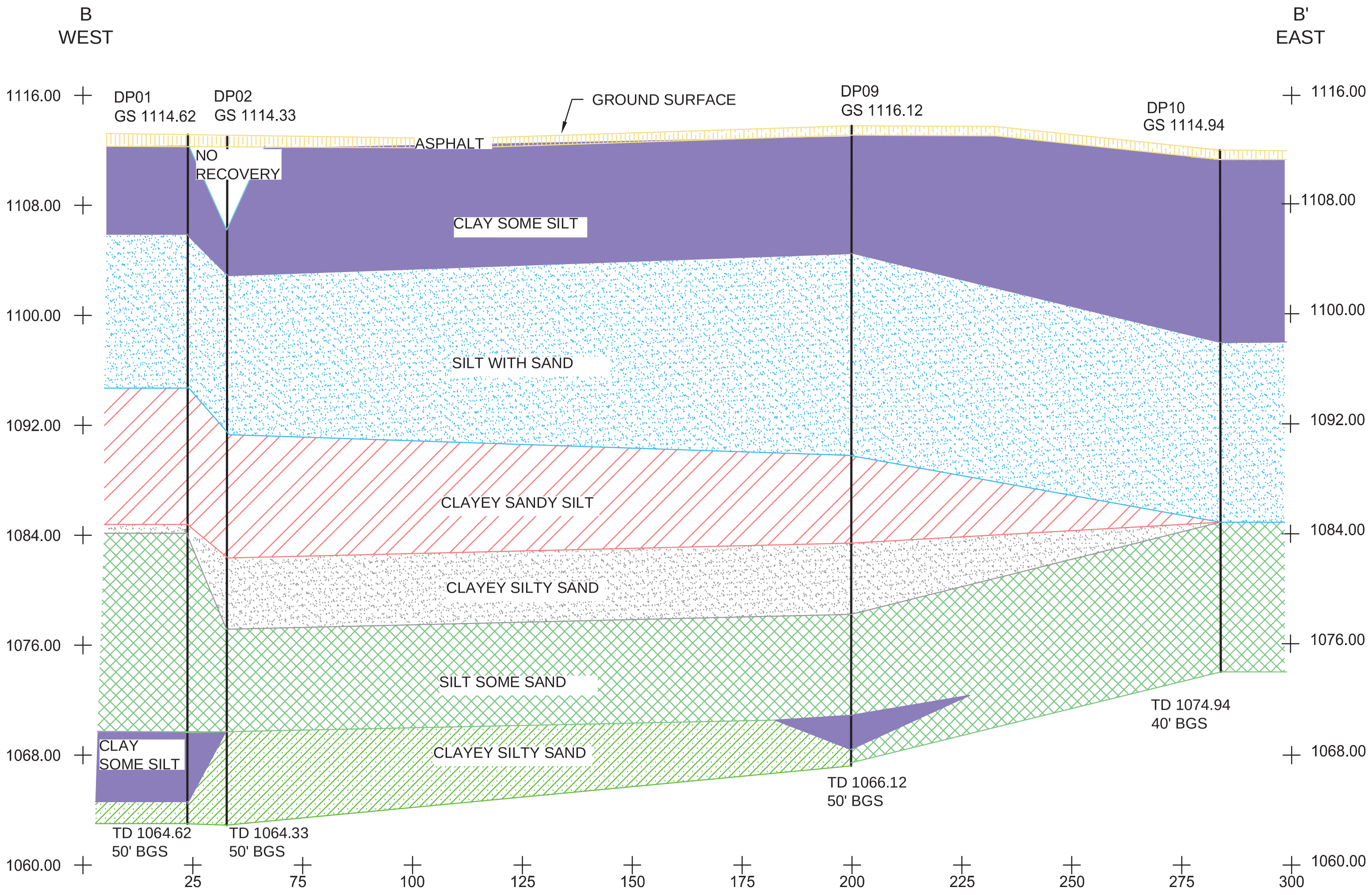
VERTICAL - 0 8' 16' SCALE IN FEET

HORIZONTAL - 0 25' 75' SCALE IN FEET

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 3-4
GEOLOGIC CROSS SECTION
A-A'
354 AREA (OU-5)
FORT RILEY, KANSAS



LEGEND

—	DIRECT-PUSH BORING	▨	SILT WITH SAND
BGS	BELOW GROUND SURFACE	▨	CLAYEY SILTY SAND
▨	ASPHALT	▨	SILT SOME SAND
☐	NO RECOVERY	▨	CLAYEY SILTY SAND
▨	SAND WITH SILT	GS	GROUND SURFACE
■	CLAY SOME SILT	— — — —	CONTACT INFERRED

NOTES:

1. ALL ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

VERTICAL - 0 8' 16' SCALE IN FEET

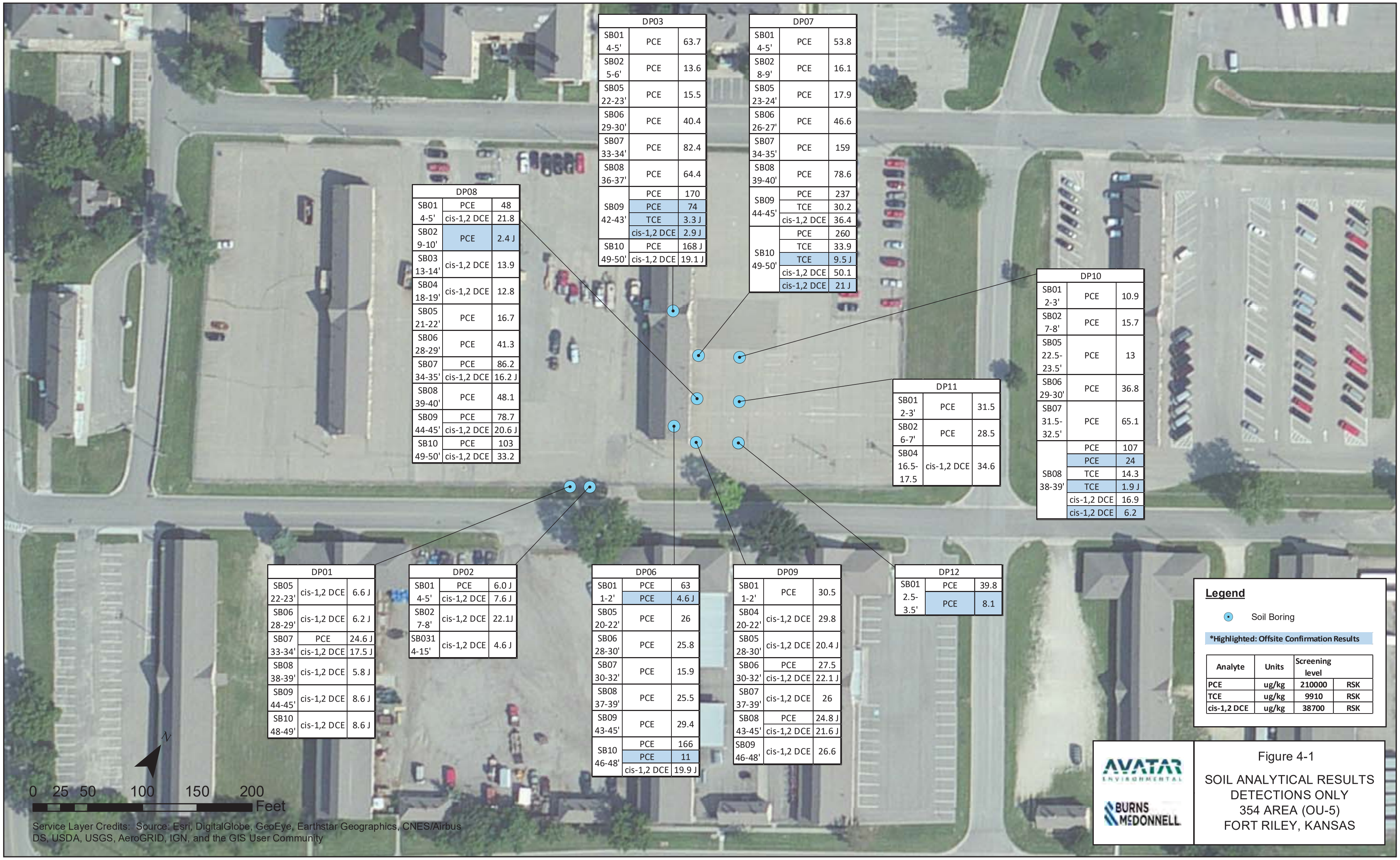
HORIZONTAL - 0 25' 75' SCALE IN FEET

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 3-5
GEOLOGIC CROSS SECTION
B-B'
354 AREA (OU-5)
FORT RILEY, KANSAS

Z:\CLIENTS\ENV\USCOE\88207_354AREABLD5320\DESIGN\CADD\DWGS\63525- 354 AREA PROFILE B-B'.DWG 9/26/2016 9:37 AM CLPATELLI



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DP03		
SB01 4-5'	PCE	63.7
SB02 5-6'	PCE	13.6
SB05 22-23'	PCE	15.5
SB06 29-30'	PCE	40.4
SB07 33-34'	PCE	82.4
SB08 36-37'	PCE	64.4
SB09 42-43'	PCE	170
	PCE	74
	TCE	3.3 J
	cis-1,2 DCE	2.9 J
SB10 49-50'	PCE	168 J
	cis-1,2 DCE	19.1 J

DP07		
SB01 4-5'	PCE	53.8
SB02 8-9'	PCE	16.1
SB05 23-24'	PCE	17.9
SB06 26-27'	PCE	46.6
SB07 34-35'	PCE	159
SB08 39-40'	PCE	78.6
SB09 44-45'	PCE	237
	TCE	30.2
	cis-1,2 DCE	36.4
SB10 49-50'	PCE	260
	TCE	33.9
	TCE	9.5 J
	cis-1,2 DCE	50.1
	cis-1,2 DCE	21 J

DP08		
SB01 4-5'	PCE	48
	cis-1,2 DCE	21.8
SB02 9-10'	PCE	2.4 J
SB03 13-14'	cis-1,2 DCE	13.9
SB04 18-19'	cis-1,2 DCE	12.8
SB05 21-22'	PCE	16.7
SB06 28-29'	PCE	41.3
SB07 34-35'	PCE	86.2
	cis-1,2 DCE	16.2 J
SB08 39-40'	PCE	48.1
SB09 44-45'	PCE	78.7
	cis-1,2 DCE	20.6 J
SB10 49-50'	PCE	103
	cis-1,2 DCE	33.2

DP10		
SB01 2-3'	PCE	10.9
SB02 7-8'	PCE	15.7
SB05 22.5-23.5'	PCE	13
SB06 29-30'	PCE	36.8
SB07 31.5-32.5'	PCE	65.1
SB08 38-39'	PCE	107
	PCE	24
	TCE	14.3
	TCE	1.9 J
	cis-1,2 DCE	16.9
	cis-1,2 DCE	6.2

DP11		
SB01 2-3'	PCE	31.5
SB02 6-7'	PCE	28.5
SB04 16.5-17.5	cis-1,2 DCE	34.6

DP01		
SB05 22-23'	cis-1,2 DCE	6.6 J
SB06 28-29'	cis-1,2 DCE	6.2 J
SB07 33-34'	PCE	24.6 J
	cis-1,2 DCE	17.5 J
SB08 38-39'	cis-1,2 DCE	5.8 J
SB09 44-45'	cis-1,2 DCE	8.6 J
SB10 48-49'	cis-1,2 DCE	8.6 J

DP02		
SB01 4-5'	PCE	6.0 J
	cis-1,2 DCE	7.6 J
SB02 7-8'	cis-1,2 DCE	22.1J
SB031 4-15'	cis-1,2 DCE	4.6 J

DP06		
SB01 1-2'	PCE	63
	PCE	4.6 J
SB05 20-22'	PCE	26
SB06 28-30'	PCE	25.8
SB07 30-32'	PCE	15.9
SB08 37-39'	PCE	25.5
SB09 43-45'	PCE	29.4
SB10 46-48'	PCE	166
	PCE	11
	cis-1,2 DCE	19.9 J

DP09		
SB01 1-2'	PCE	30.5
SB04 20-22'	cis-1,2 DCE	29.8
SB05 28-30'	cis-1,2 DCE	20.4 J
SB06 30-32'	PCE	27.5
	cis-1,2 DCE	22.1 J
SB07 37-39'	cis-1,2 DCE	26
SB08 43-45'	PCE	24.8 J
	cis-1,2 DCE	21.6 J
SB09 46-48'	cis-1,2 DCE	26.6

DP12		
SB01 2.5-3.5'	PCE	39.8
	PCE	8.1

Legend

● Soil Boring

*Highlighted: Offsite Confirmation Results

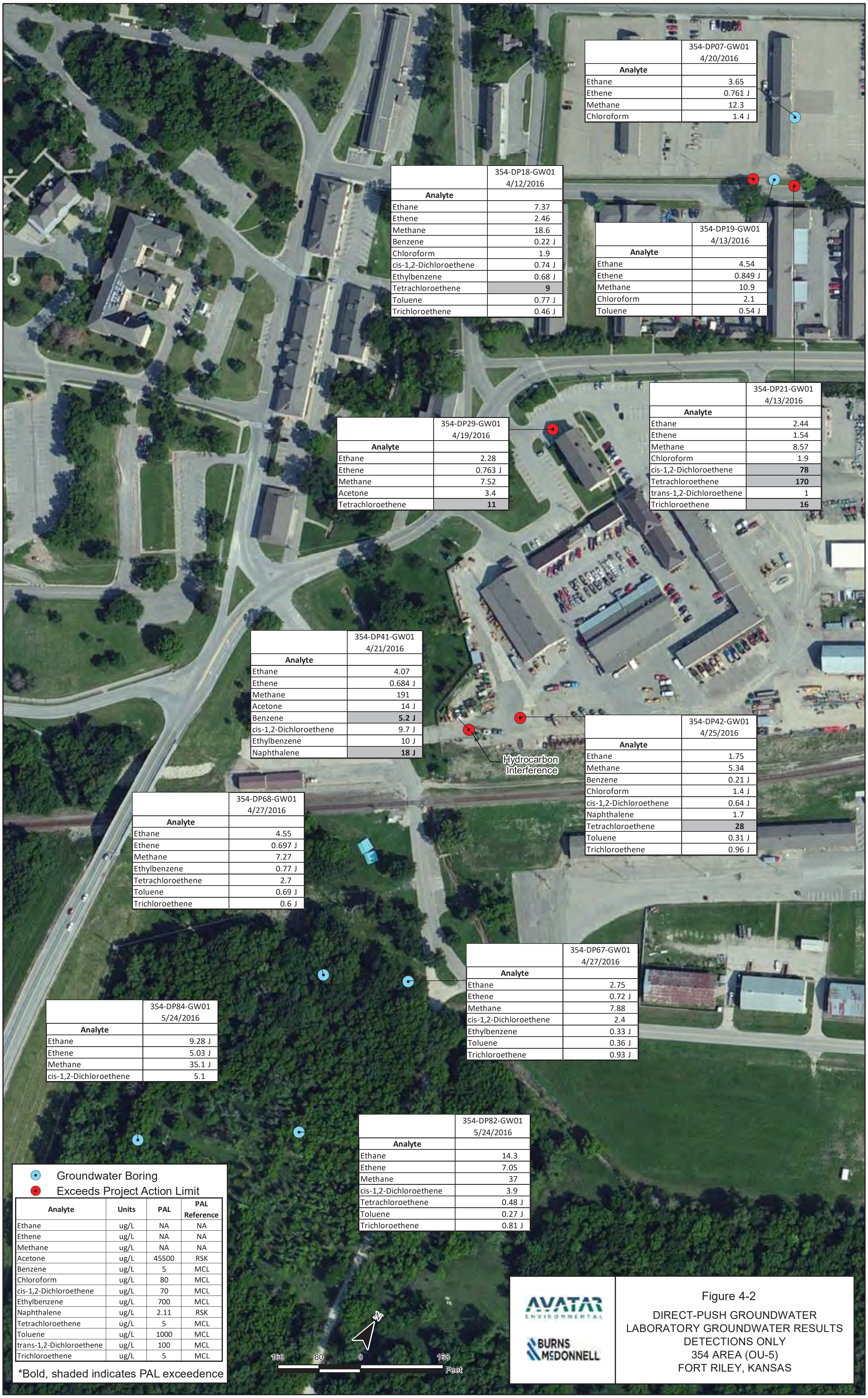
Analyte	Units	Screening level	
PCE	ug/kg	210000	RSK
TCE	ug/kg	9910	RSK
cis-1,2 DCE	ug/kg	38700	RSK

AVATAR ENVIRONMENTAL

BURNS McDONNELL

Figure 4-1

SOIL ANALYTICAL RESULTS
DETECTIONS ONLY
354 AREA (OU-5)
FORT RILEY, KANSAS



	354-DP07-GW01 4/20/2016
Analyte	
Ethane	3.65
Ethene	0.761 J
Methane	12.3
Chloroform	1.4 J

	354-DP18-GW01 4/12/2016
Analyte	
Ethane	7.37
Ethene	2.46
Methane	18.6
Benzene	0.22 J
Chloroform	1.9
cis-1,2-Dichloroethene	0.74 J
Ethylbenzene	0.68 J
Tetrachloroethene	**9**
Toluene	0.77 J
Trichloroethene	0.46 J

	354-DP19-GW01 4/13/2016
Analyte	
Ethane	4.54
Ethene	0.849 J
Methane	10.9
Chloroform	2.1
Toluene	0.54 J

	354-DP21-GW01 4/13/2016
Analyte	
Ethane	2.44
Ethene	1.54
Methane	8.57
Chloroform	1.9
cis-1,2-Dichloroethene	**78**
Tetrachloroethene	**170**
trans-1,2-Dichloroethene	1
Trichloroethene	**16**

	354-DP29-GW01 4/19/2016
Analyte	
Ethane	2.28
Ethene	0.763 J
Methane	7.52
Acetone	3.4
Tetrachloroethene	**11**

	354-DP41-GW01 4/21/2016
Analyte	
Ethane	4.07
Ethene	0.684 J
Methane	191
Acetone	14 J
Benzene	**5.2 J**
cis-1,2-Dichloroethene	9.7 J
Ethylbenzene	10 J
Naphthalene	**18 J**

	354-DP42-GW01 4/25/2016
Analyte	
Ethane	1.75
Methane	5.34
Benzene	0.21 J
Chloroform	1.4 J
cis-1,2-Dichloroethene	0.64 J
Naphthalene	1.7
Tetrachloroethene	**28**
Toluene	0.31 J
Trichloroethene	0.96 J

	354-DP68-GW01 4/27/2016
Analyte	
Ethane	4.55
Ethene	0.697 J
Methane	7.27
Ethylbenzene	0.77 J
Tetrachloroethene	2.7
Toluene	0.69 J
Trichloroethene	0.6 J

	354-DP67-GW01 4/27/2016
Analyte	
Ethane	2.75
Ethene	0.72 J
Methane	7.88
cis-1,2-Dichloroethene	2.4
Ethylbenzene	0.33 J
Toluene	0.36 J
Trichloroethene	0.93 J

	354-DP84-GW01 5/24/2016
Analyte	
Ethane	9.28 J
Ethene	5.03 J
Methane	35.1 J
cis-1,2-Dichloroethene	5.1

	354-DP82-GW01 5/24/2016
Analyte	
Ethane	14.3
Ethene	7.05
Methane	37
cis-1,2-Dichloroethene	3.9
Tetrachloroethene	0.48 J
Toluene	0.27 J
Trichloroethene	0.81 J

● Groundwater Boring

● Exceeds Project Action Limit

Analyte	Units	PAL	PAL Reference
Ethane	ug/L	NA	NA
Ethene	ug/L	NA	NA
Methane	ug/L	NA	NA
Acetone	ug/L	45500	RSK
Benzene	ug/L	5	MCL
Chloroform	ug/L	80	MCL
cis-1,2-Dichloroethene	ug/L	70	MCL
Ethylbenzene	ug/L	700	MCL
Naphthalene	ug/L	2.11	RSK
Tetrachloroethene	ug/L	5	MCL
Toluene	ug/L	1000	MCL
trans-1,2-Dichloroethene	ug/L	100	MCL
Trichloroethene	ug/L	5	MCL

*Bold, shaded indicates PAL exceedence

AVATAR ENVIRONMENTAL

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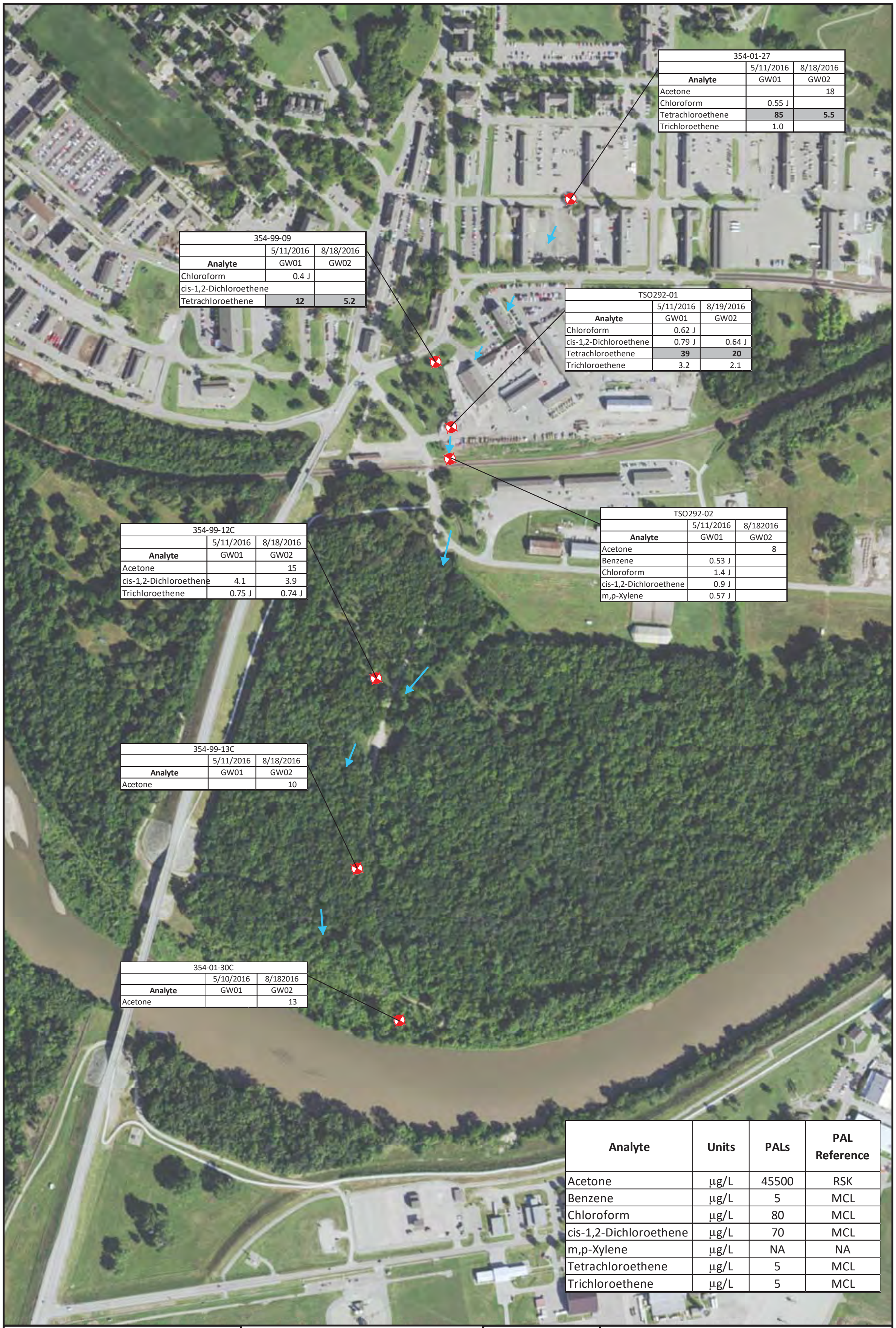
Figure 4-2

DIRECT-PUSH GROUNDWATER
LABORATORY GROUNDWATER RESULTS
DETECTIONS ONLY
354 AREA (OU-5)
FORT RILEY, KANSAS



354-01-27		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		18
Chloroform	0.55 J	
Tetrachloroethene	**85**	**5.5**
Trichloroethene	1.0	

354-99-09		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Chloroform	0.4 J	
cis-1,2-Dichloroethene		
Tetrachloroethene	**12**	**5.2**

TSO292-01		
	5/11/2016	8/19/2016
Analyte	GW01	GW02
Chloroform	0.62 J	
cis-1,2-Dichloroethene	0.79 J	0.64 J
Tetrachloroethene	**39**	**20**
Trichloroethene	3.2	2.1

TSO292-02		
	5/11/2016	8/182016
Analyte	GW01	GW02
Acetone		8
Benzene	0.53 J	
Chloroform	1.4 J	
cis-1,2-Dichloroethene	0.9 J	
m,p-Xylene	0.57 J	

354-99-12C		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		15
cis-1,2-Dichloroethene	4.1	3.9
Trichloroethene	0.75 J	0.74 J

354-99-13C		
	5/11/2016	8/18/2016
Analyte	GW01	GW02
Acetone		10

354-01-30C		
	5/10/2016	8/182016
Analyte	GW01	GW02
Acetone		13

Analyte	**Units**	**PALs**	**PAL Reference**
Acetone	µg/L	45500	RSK
Benzene	µg/L	5	MCL
Chloroform	µg/L	80	MCL
cis-1,2-Dichloroethene	µg/L	70	MCL
m,p-Xylene	µg/L	NA	NA
Tetrachloroethene	µg/L	5	MCL
Trichloroethene	µg/L	5	MCL

Legend

⊕ Monitoring wells

→ Groundwater flow direction

*Shading indicates action limit exceedence

AVATAR ENVIRONMENTAL

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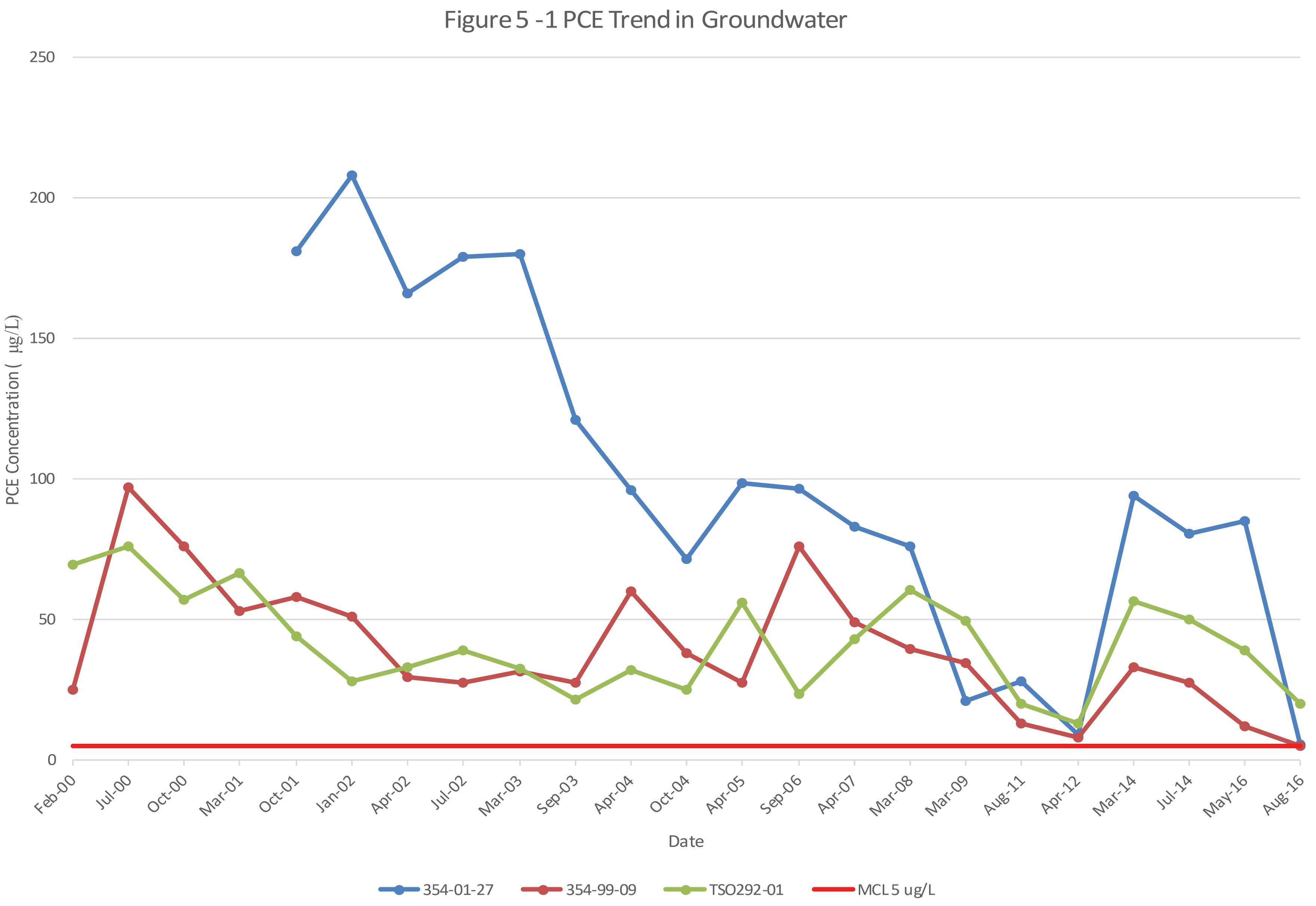
Figure 4-3
MONITORING WELL SAMPLE RESULTS
DETECTIONS ONLY
354 AREA (OU-5)
FORT RILEY, KANSAS



AVATAR ENVIRONMENTAL

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Note: Red line indicates the Federal Maximum Contaminant Level of 5 µg/l

Figure 5-1
PCE TREND IN GROUNDWATER
354 AREA (OU-5)
FORT RILEY, KANSAS

Table 1
Sample Summary
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	QC Sample Identification	SDG	Laboratory Number	Date Sampled	Analyses			
					VOCs	MEE	Metals	Miscellaneous Analyses
Field Samples								
Soil Samples (Offsite Confirmation)								
354-DP01-SB07-33-34		HS16040655	HS16040655-01	4/13/2016	X		X (Mn)	X (TOC)
354-DP01-SB77-33-34	Duplicate of 354-DP01-SB07-33-34	HS16040655	HS16040655-02	4/13/2016	X		X (Mn)	X (TOC)
354-DP02-SB02-7-8		HS16040710	HS16040710-01	4/14/2016	X		X (Mn)	X (TOC)
354-DP03-SB09-42-43		HS16040944	HS16040944-01	4/19/2016	X		X (Mn)	X (TOC)
354-DP03-SB99-42-43	Duplicate of 354-DP03-SB09-42-43	HS16040944	HS16040944-02	4/19/2016	X		X (Mn)	X (TOC)
354-DP06-SB01-1-2		HS16040768	HS16040768-01	4/15/2016	X		X (Mn)	X (TOC)
354-DP06-SB10-46-48		HS16040843	HS16040843-01	4/18/2016	X		X (Mn)	X (TOC)
354-DP07-SB10-49-50		HS16041015	HS16041015-01	4/20/2016	X		X (Mn)	X (TOC)
354-DP08-SB02-9-10		HS16040843	HS16040843-02	4/18/2016	X		X (Mn)	X (TOC)
354-DP09-SB10-46-47	MS/MSD	HS16040768	HS16040768-02	4/15/2016	X		X (Mn)	X (TOC)
354-DP10-SB08-38-39		HS16040501	HS16040501-01	4/11/2016	X		X (Mn)	X (TOC)
354-DP11-SB04-16.5-17.5		HS16040572	HS16040572-01	4/12/2016	X		X (Mn)	X (TOC)
354-DP12-SB01-2.5-3.5		HS16040572	HS16040572-02	4/12/2016	X		X (Mn)	X (TOC)
Groundwater Samples (Offsite Confirmation)								
354-DP07-GW01		HS16041015	HS16041015-03	4/20/2016	X	X		
354-DP07-GW11	Duplicate of 354-DP07-GW01	HS16041015	HS16041015-04	4/20/2016	X	X		
354-DP18-GW01		HS16040655	HS16040655-04	4/12/2016	X	X		
354-DP19-GW01		HS16040768	HS16040768-03	4/13/2016	X	X		
354-DP21-GW01		HS16040768	HS16040768-04	4/13/2016	X	X		
354-DP29-GW01	MS/MSD	HS16041015	HS16041015-02	4/19/2016	X	X		
354-DP41-GW01		HS16041146	HS16041146-01	4/21/2016	X	X		
354-DP42-GW01		HS16041397	HS16041397-01	4/25/2016	X	X		
354-DP67-GW01		HS16041397	HS16041397-02	4/27/2016	X	X		
354-DP68-GW01		HS16041459	HS16041459-01	4/27/2016	X	X		
354-DP82-GW01		HS16051494	HS16051494-01	5/24/2016	X	X		

Table 1
Sample Summary
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	QC Sample Identification	SDG	Laboratory Number	Date Sampled	Analyses			
					VOCs	MEE	Metals	Miscellaneous Analyses
354-DP82-GW11	Duplicate of 354-DP82-GW01	HS16051494	HS16051494-02	5/24/2016	X	X		
354-DP84-GW01	MS/MSD	HS16051494	HS16051494-04	5/24/2016	X	X		
Groundwater Samples (Monitoring Wells)								
TSO292-01-GW01		HS16050664	HS16050664-02	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
TSO292-02-GW01		HS16050664	HS16050664-03	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-01-27-GW01		HS16050664	HS16050664-05	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-01-27-GW11	Duplicate of 354-01-27-GW01	HS16050664	HS16050664-06	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-01-30C-GW01	MS/MSD	HS16050584	HS16050584-01	5/10/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-99-09-GW01		HS16050664	HS16050664-04	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-99-12C-GW01		HS16050664	HS16050664-08	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
354-99-13C-GW01		HS16050664	HS16050664-07	5/11/2016	X	X	X (Diss. Mn/Fe)	*Natural Attenuation
QC Samples								
Equipment Rinsate Blanks								
354-DP07-SB10R	Equipment Rinsate Blank	HS16041015	HS16041015-05	4/20/2016	X			
354-DP09-GW01R	Equipment Rinsate Blank	HS16040768	HS16040768-06	4/15/2016	X	X		
354-DP09-SB10R	Equipment Rinsate Blank	HS16040768	HS16040768-05	4/15/2016	X			
354-DP27-GW01R	Equipment Rinsate Blank	HS16041146	HS16041146-02	4/22/2016	X	X		
354-DP76-GW01R	Equipment Rinsate Blank	HS16041459	HS16041459-02	4/28/2016	X	X		
354-DP84-GW02R	Equipment Rinsate Blank	HS16051494	HS16051494-05	5/24/2016	X	X		
Trip Blanks								
354-20160415A-TB01	Trip Blank	HS16040768	HS16040768-07	4/13/2016	X	X		
354-TB-04-06/2016-03	Trip Blank	HS16040655	HS16040655-03	4/13/2016	X	X (Methane)		
354-20160420A-TB01	Trip Blank	HS16041015	HS16041015-06	4/19/2016	See Note	X (Methane)		
354-20160422A-TB01	Trip Blank	HS16041146	HS16041146-03	4/21/2016	X	X (Methane)		
354-20160427A-TB01	Trip Blank	HS16041397	HS16041397-03	4/25/2016	X	X (Methane)		
354-20160428A-TB01	Trip Blank	HS16041459	HS16041459-04	4/27/2016	X	X (Methane)		
354-05102016A-TB01	Trip Blank	HS16050584	HS16050584-02	5/10/2016	X	X (Methane)		
354-05112016A-TB01	Trip Blank	HS16050664	HS16050664-01	5/11/2016	X	X (Methane)		

Table 1
Sample Summary
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	QC Sample Identification	SDG	Laboratory Number	Date Sampled	Analyses			
					VOCs	MEE	Metals	Miscellaneous Analyses
354-20160524A-TB01	Trip Blank	HS16051494	HS16051494-06	5/24/2016	See Note	X (Methane)		

Notes: For two trip blank samples, the lab only analyzed these samples for methane, and not the VOCs as indicated on the corresponding COC.

Natural attenuation parameters include the following analyses: chloride, nitrate, nitrite, nitrate/nitrite, sulfate (all by 9056A), TOC (9060A), sulfide (4500-S2-D), and alkalinity (2320B).

Metals include dissolved iron (Fe) and dissolved manganese (Mn) for the groundwater samples and total manganese (Mn) for the soil samples (SW-846 6020).

COC = Chain Of Custody
MEE = Methane, Ethane, Ethene (RSK-175)
MS/MSD = Matrix spike/Matrix spike duplicate
QC = Quality control

SDG = Sample delivery group
TOC = Total Organic Carbon
VOC = Volatile Organic Compound (SW-846 8260B)

Table 2
Data Qualifiers Added During QA/QC Review
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Laboratory Number	Analysis	Parameter	Lab Qualifier	Data ValidationQualifier		
Field Samples							
Soil Samples (Offsite Confirmation)							
354-DP07-SB10-49-50	HS16041015-01	VOC	cis-1,2-Dichloroethene		J	MS and/or MSD outside control limits. Sample was not logged as an MS/MSD in ADR because the lab selected it to spike for the batch QC. The tetrachloroethene MS/MSD RECs were negative; hence, the rejection of this data point.	J
354-DP07-SB10-49-50	HS16041015-01	VOC	Trichloroethene		J		J
354-DP07-SB10-49-50	HS16041015-01	VOC	Tetrachloroethene		R		R
Groundwater Samples (Offsite Confirmation)							
354-DP07-GW01	HS16041015-03	VOC	Chloroform		J	LCS and/or LCSD outside control limits	J
354-DP07-GW11	HS16041015-04	VOC	Chloroform		J	LCS and/or LCSD outside control limits	J
354-DP29-GW01	HS16041015-02	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP41-GW01	HS16041146-01	VOC	Acetone		J	Surrogate outside control limits	J
		VOC	Benzene		J	Surrogate outside control limits	J
		VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
		VOC	cis-1,2-Dichloroethene		J	Surrogate outside control limits	J
		VOC	Ethylbenzene		J	Surrogate outside control limits	J
		VOC	Naphthalene		J	Surrogate outside control limits	J
354-DP42-GW01	HS16041397-01	VOC	Chloroform		J	LCS and/or LCSD outside control limits	J
354-DP67-GW01	HS16041397-02	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP68-GW01	HS16041459-01	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP82/GW01	HS16051494-01	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP82/GW11	HS16051494-02	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ

Table 2
Data Qualifiers Added During QA/QC Review
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Laboratory Number	Analysis	Parameter	Lab Qualifier	Data ValidationQualifier		
354-DP84/GW01	HS16051494-04	MEE	Ethane		J	MS and/or MSD outside control limits	J
		MEE	Ethene		J	MS and/or MSD outside control limits	J
		MEE	Methane		J	MS and/or MSD outside control limits	J
		VOC	Chloroform	U	J	LCS and/or LCSD outside control limits MS and/or MSD outside control limits	UJ
Groundwater Samples (Monitoring Wells)							
354-01-30C-GW01	HS16050584-01	VOC	1,1,2-Trichloroethane	U	J	MS and/or MSD outside control limits	UJ
		VOC	Bromodichloromethane	U	J	MS and/or MSD outside control limits	UJ
		VOC	Chlorobenzene	U	J	MS and/or MSD outside control limits	UJ
		VOC	Chloroform	U	J	LCS and/or LCSD outside control limits MS and/or MSD outside control limits	UJ
		VOC	Dibromochloromethane	U	J	MS and/or MSD outside control limits	UJ
		VOC	o-Xylene	U	J	MS and/or MSD outside control limits	UJ
		VOC	Styrene	U	J	MS and/or MSD outside control limits	UJ
		VOC	Toluene	U	J	MS and/or MSD outside control limits	UJ
TSO292-01-GW01	HS16050664-02	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	J	J	LCS and/or LCSD outside control limits	J
TSO292-02-GW01	HS16050664-03	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform		J	LCS and/or LCSD outside control limits	J
354-99-09-GW01	HS16050664-04	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	J	J	LCS and/or LCSD outside control limits	J
354-01-27-GW01	HS16050664-05	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	J	J	LCS and/or LCSD outside control limits	J

Table 2
Data Qualifiers Added During QA/QC Review
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Laboratory Number	Analysis	Parameter	Lab Qualifier	Data ValidationQualifier		
354-01-27-GW11	HS16050664-06	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	J	J	LCS and/or LCSD outside control limits	J
354-99-13C-GW01	HS16050664-07	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-99-12C-GW01	HS16050664-08	MEE	Ethene	HU	R	Holding time exceedence (12 days)	UR
		VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
QC Samples							
Equipment Rinsate Blanks							
354-DP07-SB10R	HS16041015-05	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP09-GW01R	HS16040768-06	VOC	Acetone	J	J	Surrogate outside control limits	J
354-DP27-GW01R	HS16041146-02	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-DP76-GW01R	HS16041459-02	VOC	1,1,1-Trichloroethane	U	J	Surrogate outside control limits	UJ
		VOC	Chloroform	U	J	Surrogate outside control limits LCS and/or LCSD outside control limits	UJ
		VOC	Vinyl chloride	U	J	Surrogate outside control limits	UJ
354-DP84/GW02R	HS16051494-05	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
Trip Blanks							
354-20160422A-TB01	HS16041146-03	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ
354-20160427A-TB01	HS16041397-03	VOC	Chloroform	U	J		UJ
354-20160428A-TB01	HS16041459-04	VOC	Chloroform	U	J		UJ
354-05102016A-TB01	HS16050584-02	VOC	Chloroform	U	J		UJ

Table 2
Data Qualifiers Added During QA/QC Review
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Laboratory Number	Analysis	Parameter	Lab Qualifier	Data ValidationQualifier		
354-05112016A-TB01	HS16050664-01	VOC	Chloroform	U	J	LCS and/or LCSD outside control limits	UJ

Note: Data were reviewed using Automated Data Review (ADR) software. The eQAPP used for the validation was based on Department of Defense (DoD) Quality Systems Manual (QSM) control limits. The above qualifiers added during the data validation were through the ADR software, unless otherwise noted. Copies of the ADR summaries for each sample delivery group are provided in Appendix B.

H = Holding time
J = Estimated value
LCS/LCSD = Laboratory control sample/laboratory control sample duplicate
MEE = Methane, Ethane, Ethene
MS/MSD = Matrix spike/matrix spike duplicate

U = Compound was not detected
UJ = Qualified as estimated at the reporting limit
R = Data was rejected
VOC = Volatile Organic Compound

Table 3
Analytical Completeness
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Parameter	Total Number of Parameters Overall[1]	Unacceptable Data[2]			Acceptable Data Completeness	Total Number of Parameters Based on Single Analysis by Lab[3]	Quality Data[4]	Quality Data Completeness
		R Qualified	Corrective Action?	Data Gap Exists				
Volatile Organic Compounds (VOCs)	1,786	1	N/A	1	99.9%	1,786	1,706	96%
Methane, Ethane, Ethene (MEE)	86	7	Yes	7	92%	86	76	88%
Metals (Manganese and Iron)	29	0	N/A	0	100%	29	29	100%
Natural Attenuation Analyses [5]	238	0	N/A	0	100%	238	238	100%
Grand Total =	2139	8		8	99.63%	2139	2049	96%
				Completeness Goals =	98%			80%

Notes:

1 = Total number of parameters includes duplicates, reanalyses, trip blanks, and dilutions.

2 = Acceptable data is defined as data that passed all QC criteria, or data that did not pass QC criteria but had appropriate corrective actions taken. In general, R qualified data is considered unacceptable.

3 = Total number of parameters based on single analysis by the lab includes the count of parameters as if the lab had no QC problems or corrective analyses. It is the number of parameters that would be analyzed if no QC problems were noted.

4 = Quality data includes that data in which no QC problems were noted and no corrective actions were required. The exception is for a diluted analysis due to high concentrations of target analytes and/or matrix interference or estimated trace detection flags (J).

5 =Natural attenuation parameters include the following analyses: chloride, nitrate, nitrite, nitrate/nitrite, sulfate, total organic carbon, sulfide, and alkalinity.

QC = Quality Control
N/A = Not Applicable
R = Data was rejected

Table 4
Summary of Field GC and Off-Site Confirmation Data Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Date Sampled	On-site GC Analysis (EPS) results in ppb			Off-site Confirmation Analysis (ALS) results in ug/kg (soil) and ug/L (water)		
		cis-,1,2-DCE	TCE	PCE	cis-,1,2-DCE	TCE	PCE
Soil Samples							
354-DP10-SB08-38-39	4/11/2016	16.9	13.1	91.7	6.2	1.9 J	24
354-DP11-SB04-16.5-17.5	4/12/2016	25.2 U	25.2 U	34.6	4 U	4 U	1.2 U
354-DP12-SB01-2.5-3.5	4/12/2016	25.2 U	25.2 U	39.8	4.3 U	4.3 U	8.1
354-DP01-SB07-33-34	4/13/2016	17.5 J	25.2 U	24.6 J	3.8 U	3.8 U	1.1 U
354-DP02-SB02-7-8	4/14/2016	22.1 J	25.2 U	25.2 U	3.4 U	3.4 U	1 U
354-DP06-SB01-1-2	4/15/2016	25.2 U	25.2 U	63	3.9 U	3.9 U	4.6 J
354-DP09-SB10-46-47	4/15/2016	23.4 J	25.2 U	25.2 U	3.9 U	3.9 U	1.2 U
354-DP06-SB10-46-48	4/18/2016	19.9 J	25.2 U	166	3.9 U	3.9 U	11
354-DP08-SB02-9-10	4/18/2016	12.6 U	12.6 U	12.6 U	3.8 U	3.8 U	2.4 J
354-DP03-SB09-42-43	4/19/2016	25.2 U	25.2 U	96.9	2.9 J	3.3 J	74
354-DP07-SB10-49-50	4/20/2016	50.1	33.9	312	21 J	9.5 J	160 R
Groundwater Samples							
354-DP18-GW01	4/12/2016	3 U	3 U	9.6	0.74 J	0.46 J	9
354-DP19-GW01	4/13/2016	3 U	3 U	3 U	0.5 U	0.5 U	0.5 U
354-DP21-GW01	4/13/2016	47.1	10.4	80.6	78	16	170
354-DP29-GW01	4/19/2016	3 U	3 U	6.9	0.62 U	0.62 U	11
354-DP07-GW01	4/20/2016	3 U	3 U	3.6	0.62 U	0.62 U	0.62 U
354-DP41-GW01	4/21/2016	N/A	12 U	12 U	9.7 J	0.62 U	0.62 U
354-DP42-GW01	4/25/2016	3 U	3 U	16.2	0.64 J	0.96 J	28
354-DP67-GW01	4/27/2016	3 U	3 U	3 U	2.4	0.93 J	0.62 U
354-DP68-GW01	4/27/2016	3 U	3 U	5.2	0.62 U	0.6 J	2.7
354-DP82-GW01	5/24/2016	2	2 U	2 U	3.9	0.81 J	0.48 J
354-DP84-GW01	5/24/2016	3.7	2 U	2 U	5.1	0.62 U	0.62 U

Note: For duplicate results, the higher detection was reported. Review of the duplicate comparisons is discussed in the text.

cis-1,2-DCE = cis-1,2-Dichloroethene
EPS = Environmental Priority Services, Inc.
GC = Gas Chromatograph
J = Estimated value.
N/A = Interference Noted no result reported.
ppb = parts per billion
PCE = Tetrachloroethene

QCSR = Quality Control Summary Report
R = Data was rejected
U = Compound was not detected. Value is the reporting limit.
µg/L = micrograms per liter
TCE = Trichloroethene

Table 5
Linear Regression Field GC & OffSite Confirmation Data Soil Results (Detections Only)
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Date Sampled	Detected Analyte(s)	EPS (Onsite)	ALS (Offsite)
			ppb	ug/kg
Soil Samples				
354-DP10-SB08-38-39	4/11/2016	cis-,1,2-DCE	16.9	6.2
		TCE	13.1	1.9 J
		PCE	91.7	24
354-DP11-SB04-16.5-17.5	4/12/2016	PCE	34.6	
354-DP12-SB01-2.5-3.5	4/12/2016	PCE	39.8	8.1
354-DP01-SB07-33-34	4/13/2016	cis-,1,2-DCE	17.5 J	
		PCE	24.6 J	
354-DP02-SB02-7-8	4/14/2016	cis-,1,2-DCE	22.1 J	
354-DP06-SB01-1-2	4/15/2016	PCE	63	4.6 J
354-DP09-SB10-46-47	4/15/2016	cis-,1,2-DCE	23.4 J	
354-DP06-SB10-46-48	4/18/2016	cis-,1,2-DCE	19.9 J	
		PCE	166	11
354-DP08-SB02-9-10	4/18/2016	PCE		2.4 J
354-DP03-SB09-42-43	4/19/2016	cis-,1,2-DCE		2.9 J
		TCE		3.3 J
		PCE	96.9	74
354-DP07-SB10-49-50	4/20/2016	cis-,1,2-DCE	50.1	21 J
		TCE	33.9	9.5 J
		PCE	312	

Linear Regression Results	
Slope	0.788378936
Intercept	49.44698407
r^2 (correlation coefficient)	0.131889637
Linear Regression Acceptance Criteria $r^2 \geq 0.70$	

Notes:

Gray cell indicates nondetect. Only detections were included in these calculations.

cis-1,2-DCE = cis-1,2-Dichloroethene
EPS = Environmental Priority Services, Inc.
J = Estimated value.
ppb = parts per billion
PCE = Tetrachloroethene
µg/L = micrograms per liter
TCE = Trichloroethene

Table 6
Linear Regression Field GC & OffSite Confirmation Data Groundwater Results (Detections Only)
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

Sample Identification	Date Sampled	Detected Analyte(s)	EPS (Onsite)	ALS (Offsite)
			ppb	ug/L
Groundwater Samples				
354-DP18-GW01	4/12/2016	cis-,1,2-DCE	▨	0.74 J
		TCE	▨	0.46 J
		PCE	9.6	9
354-DP21-GW01	4/13/2016	cis-,1,2-DCE	47.1	78
		TCE	10.4	16
		PCE	80.6	170
354-DP29-GW01	4/19/2016	PCE	6.9	11
354-DP07-GW01	4/20/2016	PCE	3.6	▨
354-DP41-GW01	4/21/2016	cis-,1,2-DCE	▨	9.7 J
354-DP42-GW01	4/25/2016	cis-,1,2-DCE	▨	0.64 J
		TCE	▨	0.96 J
		PCE	16.2	28
354-DP67-GW01	4/27/2016	cis-,1,2-DCE	▨	2.4
		TCE	▨	0.93 J
354-DP68-GW01	4/27/2016	TCE	▨	0.6 J
		PCE	5.2	2.7
354-DP82-GW01	5/24/2016	cis-,1,2-DCE	2	3.9
	5/24/2016	TCE	▨	0.81 J
		PCE	▨	0.48 J
354-DP84-GW01	5/24/2016	cis-,1,2-DCE	3.7	5.1

Linear Regression Results	
Slope	0.473514912
Intercept	3.158135883
r^2 (correlation coefficient)	0.985963027
Linear Regression Acceptance Criteria $r^2 \geq 0.70$	

Notes:

Gray cell indicates nondetect. Only detections were included in these calculations.

cis-1,2-DCE = cis-1,2-Dichloroethene
EPS = Environmental Priority Services, Inc.
J = Estimated value.
ppb = parts per billion
PCE = Tetrachloroethene
µg/L = micrograms per liter
TCE = Trichloroethene

Appendix A – Data Summary Tables

Table A-1 Area 354 Direct Push Soil Results
Table A-2 Area 354 Direct Push Groundwater Sample Results
Table A-3 Area 354 Monitoring Well Sample Results
Table A-4 Summary of Field Quality Control Sample Results

Table A-1
Area 354 Direct Push Soil Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

			Sample ID:	354-DP01-SB07-33-34	354-DP01-SB77-33-34	354-DP02-SB02-7-8	354-DP03-SB09-42-43	354-DP03-SB99-42-43	354-DP06-SB01-1-2	354-DP06-SB10-46-48	354-DP07-SB10-49-50	354-DP08-SB02-9-10
			Lab ID:	4/13/2016	4/13/2016	4/14/2016	4/19/2016	4/19/2016	4/15/2016	4/18/2016	4/20/2016	4/18/2016
			Date Collected:	HS16040655-01	HS16040655-02	HS16040710-01	HS16040944-01	HS16040944-02	HS16040768-01	HS16040843-01	HS16041015-01	HS16040843-02
			Depth (ft bgs):	33-34	33-34	7-8	42-43	42-43	1-2	46-48	49-50	9-10
		Project Action Limit			Field Duplicate			Field Duplicate				
Analyte	Units		Reference	Result	Result	Result	Result	Result	Result	Result	Result	Result
1,1,1-Trichloroethane	µg/kg	18100000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,1,2,2-Tetrachloroethane	µg/kg	15200	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,1,2-Trichloroethane	µg/kg	3370	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,1-Dichloroethane	µg/kg	79900	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,1-Dichloroethene	µg/kg	484000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,2-Dichloroethane	µg/kg	10900	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,2-Dichloropropane	µg/kg	22300	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
1,4-Dichlorobenzene	µg/kg	63700	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
2-Butanone	µg/kg	101000000	RSK	2.4 U	2.3 U	2.1 U	2.4 U	2.6 U	2.5 U	2.5 U	2.3 U	2.4 U
2-Hexanone	µg/kg	13000000	RSL	2.4 U	2.3 U	2.1 U	2.4 U	2.6 U	2.5 U	2.5 U	2.3 U	2.4 U
4-Methyl-2-pentanone	µg/kg	34800000	RSK	2.4 U	2.3 U	2.1 U	2.4 U	2.6 U	2.5 U	2.5 U	2.3 U	2.4 U
Acetone	µg/kg	406000000	RSK	7.7 U	7.3 U	6.8 U	2.4 U	2.6 U	7.9 U	7.9 U	7.5 U	7.7 U
Benzene	µg/kg	28200	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Bromodichloromethane	µg/kg	6690	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Bromoform	µg/kg	3120000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Bromomethane	µg/kg	14600	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Carbon disulfide	µg/kg	1680000	RSK	2.4 U	2.3 U	2.1 U	2.4 U	2.6 U	2.5 U	2.5 U	2.3 U	2.4 U
Carbon tetrachloride	µg/kg	14700	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Chlorobenzene	µg/kg	740000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Chloroethane	µg/kg	28100000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Chloroform	µg/kg	7140	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Chloromethane	µg/kg	223000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
cis-1,2-Dichloroethene	µg/kg	38700	RSK	3.8 U	3.6 U	3.4 U	2.9 J	2.3 J	3.9 U	3.9 U	21 J	3.8 U
cis-1,3-Dichloropropene	µg/kg	NA	NA	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Dibromochloromethane	µg/kg	294000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Ethylbenzene	µg/kg	145000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
m,p-Xylene	µg/kg	NA	NA	2.4 U	2.3 U	2.1 U	2.4 U	2.6 U	2.5 U	2.5 U	2.3 U	2.4 U
Methyl tert-butyl ether	µg/kg	1050000	RSK	3.8 U	3.6 U	3.4 U	1.1 U	1.2 U	3.9 U	3.9 U	3.8 U	3.8 U
Methylene chloride	µg/kg	1880000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Naphthalene	µg/kg	64700	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
o-Xylene	µg/kg	2800000	RSL	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Styrene	µg/kg	20400000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Tetrachloroethene	µg/kg	210000	RSK	1.1 U	1.1 U	1 U	74	63	4.6 J	11	160 R	2.4 J
Toluene	µg/kg	29800000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
trans-1,2-Dichloroethene	µg/kg	333000	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
trans-1,3-Dichloropropene	µg/kg	NA	NA	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Trichloroethene	µg/kg	9910	RSK	3.8 U	3.6 U	3.4 U	3.3 J	2.8 J	3.9 U	3.9 U	9.5 J	3.8 U
Vinyl chloride	µg/kg	9210	RSK	1.1 U	1.1 U	1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U
Manganese	mg/kg	66200	RSK	198	191	190	60	86.7	182	117	35.8	413
Percent Moisture	%	NA	NA	16.4	15.4	10.9	15.4	15.3	14.8	14.6	20.1	15.3
Total Organic Carbon	%-dry	NA	NA	0.203	0.246	0.152	0.06 U	0.06 U	1.7	0.06 U	0.06 U	0.24

Bold, shaded indicates action limit exceedence

J = Estimated value

R = Data rejected

U = Compound was not detected

NA = not available

ug/kg = micrograms per kilogram

% dry wt= Percent Dry Weight

KDHE RSK at HQ=1 or TR=1E-05 (September, 2015)

EPA industrial Soil RSL at HQ=1 or Cancer TR=1E-05 (May, 2016)

RSK=Risk-based Standards (Kansas) - non-residential

RSL=EPA Regional Screening Levels

Table A-1
Area 354 Direct Push Soil Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

			Sample ID:	354-DP09-SB10-46-47	354-DP10-SB08-38-39	354-DP11-SB04-16.5-17.5	354-DP12-SB01-2.5-3.5
			Lab ID:	4/15/2016	4/11/2016	4/12/2016	4/12/2016
			Date Collected:	HS16040768-02	HS16040501-01	HS16040572-01	HS16040572-02
			Depth (ft bgs):	46-47	38-39	16.5-17	2.5-3.5
		Project Action Limit					
Analyte	**Units**		**Reference**	**Result**	**Result**	**Result**	**Result**
1,1,1-Trichloroethane	µg/kg	18100000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,1,2,2-Tetrachloroethane	µg/kg	15200	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,1,2-Trichloroethane	µg/kg	3370	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,1-Dichloroethane	µg/kg	79900	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,1-Dichloroethene	µg/kg	484000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,2-Dichloroethane	µg/kg	10900	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,2-Dichloropropane	µg/kg	22300	RSK	1.2 U	1.2 U	1.2 U	1.3 U
1,4-Dichlorobenzene	µg/kg	63700	RSK	1.2 U	1.2 U	1.2 U	1.3 U
2-Butanone	µg/kg	101000000	RSK	2.4 U	2.4 U	2.5 U	2.7 U
2-Hexanone	µg/kg	13000000	RSL	2.4 U	2.4 U	2.5 U	2.7 U
4-Methyl-2-pentanone	µg/kg	34800000	RSK	2.4 U	2.4 U	2.5 U	2.7 U
Acetone	µg/kg	406000000	RSK	7.8 U	2.4 U	8.1 U	8.7 U
Benzene	µg/kg	28200	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Bromodichloromethane	µg/kg	6690	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Bromoform	µg/kg	3120000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Bromomethane	µg/kg	14600	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Carbon disulfide	µg/kg	1680000	RSK	2.4 U	2.4 U	2.5 U	2.7 U
Carbon tetrachloride	µg/kg	14700	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Chlorobenzene	µg/kg	740000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Chloroethane	µg/kg	28100000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Chloroform	µg/kg	7140	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Chloromethane	µg/kg	223000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
cis-1,2-Dichloroethene	µg/kg	38700	RSK	3.9 U	6.2	4 U	4.3 U
cis-1,3-Dichloropropene	µg/kg	NA	NA	1.2 U	1.2 U	1.2 U	1.3 U
Dibromochloromethane	µg/kg	294000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Ethylbenzene	µg/kg	145000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
m,p-Xylene	µg/kg	NA	NA	2.4 U	2.4 U	2.5 U	2.7 U
Methyl tert-butyl ether	µg/kg	1050000	RSK	3.9 U	1.2 U	4 U	4.3 U
Methylene chloride	µg/kg	1880000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Naphthalene	µg/kg	64700	RSK	1.2 U	1.2 U	1.2 U	1.3 U
o-Xylene	µg/kg	2800000	RSL	1.2 U	1.2 U	1.2 U	1.3 U
Styrene	µg/kg	20400000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Tetrachloroethene	µg/kg	210000	RSK	1.2 U	24	1.2 U	8.1
Toluene	µg/kg	29800000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
trans-1,2-Dichloroethene	µg/kg	333000	RSK	1.2 U	1.2 U	1.2 U	1.3 U
trans-1,3-Dichloropropene	µg/kg	NA	NA	1.2 U	1.2 U	1.2 U	1.3 U
Trichloroethene	µg/kg	9910	RSK	3.9 U	1.9 J	4 U	4.3 U
Vinyl chloride	µg/kg	9210	RSK	1.2 U	1.2 U	1.2 U	1.3 U
Manganese	mg/kg	66200	RSK	223	213	22.1	198
Percent Moisture	%	NA	NA	11.5	15.5	7.9	15.2
Total Organic Carbon	%-dry	NA	NA	0.06 U	0.06 U	0.06 U	1.46

Bold, shaded indicates action limit exceedence

J = Estimated value

R = Data rejected

U = Compound was not detected

NA = not available

ug/kg = micrograms per kilogram

% dry wt= Percent Dry Weight

KDHE RSK at HQ=1 or TR=1E-05 (September, 2015)

EPA industrial Soil RSL at HQ=1 or Cancer TR=1E-05 (May, 2016)

RSK=Risk-based Standards (Kansas) - non-residential

RSL=EPA Regional Screening Levels

Table A-2
Area 354 Direct Push Groundwater Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

			Sample ID:	354-DP07-GW01	354-DP07-GW11	354-DP18-GW01	354-DP19-GW01	354-DP21-GW01	354-DP29-GW01	354-DP41-GW01	354-DP42-GW01	354-DP67-GW01
			Lab ID:	HS16041015-03	HS16041015-04	HS16040655-04	HS16040768-03	HS16040768-04	HS16041015-02	HS16041146-01	HS16041397-01	HS16041397-02
			Date Collected:	4/20/2016	4/20/2016	4/12/2016	4/13/2016	4/13/2016	4/19/2016	4/21/2016	4/25/2016	4/27/2016
		Project Action Limit			Field Duplicate							
Analyte	**Units**		**Reference**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Ethane	µg/L	NA	NA	3.65	3.4	7.37	4.54	2.44	2.28	4.07	1.75	2.75
Ethene	µg/L	NA	NA	0.761 J	0.667 J	2.46	0.849 J	1.54	0.763 J	0.684 J	0.337 U	0.72 J
Methane	µg/L	NA	NA	12.3	11.7	18.6	10.9	8.57	7.52	191	5.34	7.88
1,1,1-Trichloroethane	µg/L	200	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2,2-Tetrachloroethane	µg/L	1.28	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2-Trichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethane	µg/L	46.1	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethene	µg/L	7	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloropropane	µg/L	5	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
1,4-Dichlorobenzene	µg/L	75	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
2-Butanone	µg/L	11800	RSK	1.2 U	1.2 U	1 U	1 U	1 U	1.2 U	1.2 U	1.2 U	1.2 U
2-Hexanone	µg/L	NA	NA	1.2 U	1.2 U	1 U	1 U	1 U	1.2 U	1.2 U	1.2 U	1.2 U
4-Methyl-2-pentanone	µg/L	4170	RSK	1.2 U	1.2 U	1 U	1 U	1 U	1.2 U	1.2 U	1.2 U	1.2 U
Acetone	µg/L	45500	RSK	2 U	2 U	1 U	1 U	1 U	3.4	14 J	2 U	2 U
Benzene	µg/L	5	MCL	0.62 U	0.62 U	0.22 J	0.5 U	0.5 U	0.62 U	**5.2** J	0.21 J	0.62 U
Bromodichloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Bromoform	µg/L	80	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Bromomethane	µg/L	13.2	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Carbon disulfide	µg/L	1660	RSK	1.2 U	1.2 U	1 U	1 U	1 U	1.2 U	1.2 U	1.2 U	1.2 U
Carbon tetrachloride	µg/L	5	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Chlorobenzene	µg/L	100	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Chloroethane	µg/L	26400	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Chloroform	µg/L	80	MCL	1.4 J	1.3 J	1.9	2.1	1.9	0.62 UJ	0.62 UJ	1.4 J	0.62 UJ
Chloromethane	µg/L	238	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
cis-1,2-Dichloroethene	µg/L	70	MCL	0.62 U	0.62 U	0.74 J	0.5 U	**78**	0.62 U	9.7 J	0.64 J	2.4
cis-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Dibromochloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Ethylbenzene	µg/L	700	MCL	0.62 U	0.62 U	0.68 J	0.5 U	0.5 U	0.62 U	10 J	0.62 U	0.33 J
m,p-Xylene	µg/L	NA	NA	1.2 U	1.2 U	1 U	1 U	1 U	1.2 U	1.2 U	1.2 U	1.2 U
Methyl tert-butyl ether	µg/L	262	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Methylene chloride*	µg/L	5	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Naphthalene	µg/L	2.11	RSK	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	**18** J	1.7	0.62 U
o-Xylene	µg/L	NA	NA	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Styrene	µg/L	100	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Tetrachloroethene	µg/L	5	MCL	0.62 U	0.62 U	**9**	0.5 U	**170**	**11**	0.62 U	**28**	0.62 U
Toluene	µg/L	1000	MCL	0.62 U	0.62 U	0.77 J	0.54 J	0.5 U	0.62 U	0.62 U	0.31 J	0.36 J
trans-1,2-Dichloroethene	µg/L	100	MCL	0.62 U	0.62 U	0.5 U	0.5 U	1	0.62 U	0.62 U	0.62 U	0.62 U
trans-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U
Trichloroethene	µg/L	5	MCL	0.62 U	0.62 U	0.46 J	0.5 U	**16**	0.62 U	0.62 U	0.96 J	0.93 J
Vinyl chloride	µg/L	2	MCL	0.62 U	0.62 U	0.5 U	0.5 U	0.5 U	0.62 U	0.62 U	0.62 U	0.62 U

Bold, shaded indicates action limit exceedence

J = Estimated value

UJ = Compound was not detected/estimated value

U = Compound was not detected

NA = Not available

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR=1E-05 (September, 2015)

MCL=EPA Maximum Contaminant Level Standards

*Results are unvalidated

Table A-2
Area 354 Direct Push Groundwater Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

			Sample ID:	354-DP68-GW01	354-DP82-GW01	354-DP82-GW11	354-DP84-GW01
			Lab ID:	HS16041459-01	HS16051494-01	HS16051494-02	HS16051494-04
			Date Collected:	4/27/2016	5/24/2016	5/24/2016	5/24/2016
		Project Action Limit				Field Duplicate	
Analyte	**Units**		**Reference**	**Result**	**Result**	**Result**	**Result**
Ethane	µg/L	NA	NA	4.55	5.58	14.3	9.28 J
Ethene	µg/L	NA	NA	0.697 J	2.7	7.05	5.03 J
Methane	µg/L	NA	NA	7.27	14.3	37	35.1 J
1,1,1-Trichloroethane	µg/L	200	MCL	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2,2-Tetrachloroethane	µg/L	1.28	RSK	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2-Trichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethane	µg/L	46.1	RSK	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethene	µg/L	7	MCL	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloropropane	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U
1,4-Dichlorobenzene	µg/L	75	MCL	0.62 U	0.62 U	0.62 U	0.62 U
2-Butanone	µg/L	11800	RSK	1.2 U	1.2 U	1.2 U	1.2 U
2-Hexanone	µg/L	NA	NA	1.2 U	1.2 U	1.2 U	1.2 U
4-Methyl-2-pentanone	µg/L	4170	RSK	1.2 U	1.2 U	1.2 U	1.2 U
Acetone	µg/L	45500	RSK	2 U	2.5 U	2.5 U	2.5 U
Benzene	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Bromodichloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Bromoform	µg/L	80	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Bromomethane	µg/L	13.2	RSK	0.62 U	0.62 U	0.62 U	0.62 U
Carbon disulfide	µg/L	1660	RSK	1.2 U	1.2 U	1.2 U	1.2 U
Carbon tetrachloride	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Chlorobenzene	µg/L	100	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Chloroethane	µg/L	26400	RSK	0.62 U	0.62 U	0.62 U	0.62 U
Chloroform	µg/L	80	MCL	0.62 UJ	0.62 UJ	0.62 UJ	0.62 UJ
Chloromethane	µg/L	238	RSK	0.62 U	0.62 U	0.62 U	0.62 U
cis-1,2-Dichloroethene	µg/L	70	MCL	0.62 U	3.7	3.9	5.1
cis-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.62 U	0.62 U
Dibromochloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Ethylbenzene	µg/L	700	MCL	0.77 J	0.62 U	0.62 U	0.62 U
m,p-Xylene	µg/L	NA	NA	1.2 U	1.2 U	1.2 U	1.2 U
Methyl tert-butyl ether	µg/L	262	RSK	0.62 U	0.62 U	0.62 U	0.62 U
Methylene chloride*	µg/L	5	MCL	0.62	0.62 U	0.62 U	0.62 U
Naphthalene	µg/L	2.11	RSK	0.62 U	0.62 U	0.62 U	0.62 U
o-Xylene	µg/L	NA	NA	0.62 U	0.62 U	0.62 U	0.62 U
Styrene	µg/L	100	MCL	0.62 U	0.62 U	0.62 U	0.62 U
Tetrachloroethene	µg/L	5	MCL	2.7	0.48 J	0.42 J	0.62 U
Toluene	µg/L	1000	MCL	0.69 J	0.27 J	0.26 J	0.62 U
trans-1,2-Dichloroethene	µg/L	100	MCL	0.62 U	0.62 U	0.62 U	0.62 U
trans-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.62 U	0.62 U
Trichloroethene	µg/L	5	MCL	0.6 J	0.81 J	0.76 J	0.62 U
Vinyl chloride	µg/L	2	MCL	0.62 U	0.62 U	0.62 U	0.62 U

Bold, shaded indicates action limit exceedence

J = Estimated value

UJ = Compound was not detected/estimated value

U = Compound was not detected

NA = Not available

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR

MCL=EPA Maximum Contaminant Level Standards

*Results are unvalidated

Table A-3
Area 354 Monitoring Well Groundwater Results
Area 354 PDI and Groundwater Monitoring Event 1
Fort Riley, Kansas

			Sample ID:	354-01-27-GW01	354-01-27-GW11	354-01-30C-GW01	354-99-09-GW01	354-99-12C-GW01	354-99-13C-GW01	TSO292-01-GW01	TSO292-02-GW01
			Lab ID:	HS16050664-05	HS16050664-06	HS16050584-01	HS16050664-04	HS16050664-08	HS16050664-07	HS16050664-02	HS16050664-03
			Date Collected:	5/11/2016	5/11/2016	5/10/2016	5/11/2016	5/11/2016	5/11/2016	5/11/2016	5/11/2016
		Project Action Limit			Field Duplicate						
Analyte	**Units**		**Reference**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Alkalinity, Total (As CaCO3)	mg/L	NA	NA	311	314	426	281	405	358	323	507
Chloride	mg/L	250	Secondary MCL	87.1	86.3	49.2	**353**	**471**	72.4	**310**	155
Nitrate/Nitrite (as N)	mg/L	10	MCL	8.42	8.20	0.05 J	**11.90**	0.04 J	0.12	9.42	0.05 J
Nitrogen, Nitrate (As N)	mg/L	10	MCL	8.42	8.20	0.05 J	**11.90**	0.04 J	0.12	9.42	0.05 J
Nitrogen, Nitrite (As N)	mg/L	1	MCL	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Sulfate	mg/L	250	Secondary MCL	65.4	64.0	115	70.7	169	130	102	8.0
Ethane	µg/L	NA	NA	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	1.93
Ethene	µg/L	NA	NA	0.34 UR	0.34 UR	0.34 U	0.34 UR	0.34 UR	0.34 UR	0.34 UR	0.34 UR
Methane	µg/L	NA	NA	0.2 U	0.2 U	5.0	0.2 U	0.2 U	0.2 U	4.0	134.0
Iron	mg/L	0.3	Secondary MCL	0.2 U	0.2 U	**1.1**	0.2 U	**9.3**	**8.4**	0.2 U	**13.1**
Manganese	mg/L	0.05	Secondary MCL	0.001 U	0.001 U	**1.520**	0.001 U	**0.525**	**1.370**	0.007	**0.484**
Sulfide	mg/L	NA	NA	0.03 U	25 U	0.03 U	25 U	0.03 U	0.02 J	25 U	0.11
Organic Carbon, Total	mg/L	NA	NA	1.13	1.12	1.79	1.05	1.55	1.90	1.28	3.26
1,1,1-Trichloroethane	µg/L	200	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2,2-Tetrachloroethane	µg/L	1.28	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1,2-Trichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethane	µg/L	46.1	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,1-Dichloroethene	µg/L	7	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloroethane	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,2-Dichloropropane	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
1,4-Dichlorobenzene	µg/L	75	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
2-Butanone	µg/L	11800	RSK	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
2-Hexanone	µg/L	NA	NA	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
4-Methyl-2-pentanone	µg/L	4170	RSK	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Acetone	µg/L	45500	RSK	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Benzene	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.53 J
Bromodichloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Bromoform	µg/L	80	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Bromomethane	µg/L	13.2	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Carbon disulfide	µg/L	1660	RSK	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Carbon tetrachloride	µg/L	5	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Chlorobenzene	µg/L	100	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Chloroethane	µg/L	26400	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Chloroform	µg/L	80	MCL	0.55 J	0.58 J	0.62 UJ	0.36 J	0.62 UJ	0.62 UJ	0.62 J	1.40 J
Chloromethane	µg/L	238	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
cis-1,2-Dichloroethene	µg/L	70	MCL	0.62 U	0.62 U	0.62 U	0.62 U	4.10	0.62 U	0.79 J	0.90 J
cis-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Dibromochloromethane	µg/L	80	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Ethylbenzene	µg/L	700	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
m,p-Xylene	µg/L	NA	NA	1.20 U	1.20 U	1.20 U	1.20 U	1.20 U	1.20 U	1.20 U	0.57 J
Methyl tert-butyl ether	µg/L	262	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Methylene chloride*	µg/L	5	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Naphthalene	µg/L	2.11	RSK	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
o-Xylene	µg/L	NA	NA	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Styrene	µg/L	100	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Tetrachloroethene	µg/L	5	MCL	**85**	**85**	0.62 U	**12**	0.62 U	0.62 U	**39**	0.62 U
Toluene	µg/L	1000	MCL	0.62 U	0.62 U	0.62 UJ	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
trans-1,2-Dichloroethene	µg/L	100	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
trans-1,3-Dichloropropene	µg/L	NA	NA	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U
Trichloroethene	µg/L	5	MCL	1	1	0.62 U	0.62 U	0.75 J	0.62 U	3	0.62 U
Vinyl chloride	µg/L	2	MCL	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U	0.62 U

Bold, shaded indicates action limit exceedence

J = Estimated value

UJ = Compound was not detected/estimated value

UR = Not detected/rejected

U = Compound was not detected

NA = not available

µg/L = micrograms per liter

RSK=Risk-based Standards (Kansas) - non-residential groundwater at HQ=1 or Cancer TR=1E-05 (September, 2015)

MCL=EPA Maximum Contaminant Level Standards

*Results are unvalidated

Table 3.2a
Field Monitoring Parameters
March 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well ID	Date Sampled	Sample Time	Approximate Amount Purged (Liters)	Flow Rate (mL/min)	Temperature (°C)	pH	Conductivity (mS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Fe^{+2} (ppm)	Water Level (ft btoc)
354-01-27	3/19/2014	1005	5.23	115	14.18	6.95	763	1.11	205	5.63	0.05	52.55
354-99-09	3/18/2014	1650	4.25	100	14.73	6.81	1371	2.88	119.9	5.80	0.04	*
TS0292-01	3/19/2014	1155	6.1	100	14.72	6.64	1792	0.39	121.1	1.19	0.05	24.80
TS0292-02	3/18/2014	1455	3.7	80	14.34	6.75	1743	1.39	-81.3	1.04	1.29	*

Table 3.2b
Field Monitoring Parameters
July 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well ID	Date Sampled	Sampling Time	Approximate Amount Purged (Liters)	Flow Rate (mL/min)	Temperature (°C)	pH	Conductivity (mS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Fe^{+2} (ppm)	Water Level (ft btoc)
354-01-27	7/16/2014	1015	6.48	130	18.25	6.59	647	1.21	135.8	6.4	0	51.82
354-99-09	7/16/2014	1205	5.9	150	15.74	6.53	1294	6.23	122.4	5.86	0.03	*
TS0292-01	7/16/2014	1440	5.2	130	18.42	6.58	1330	1.11	62.8	0.63	0	24.76
TS0292-02	7/16/2014	1650	6.43	90	19.31	6.55	975	1.24	-75.4	1.3	1.66	*

Notes:

* = water level below top of pump
°C = degrees Celsius
DO = dissolved oxygen
Fe^{+2} = ferrous iron
ft btoc = feet below top of casing
ID = identification
mg/L = milligrams per liter
mL/min = milliliters per minute
mS/cm = millisiemens per centimeter
mV = millivolts
NTU = nephelometric turbidity units
ORP = oxygen reduction potential
ppm = parts per million

Table 3.3a
Laboratory Analytical Summary
March 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**354-01-27**	**354-99-09**	**TSO292-01**	**TSO292-02**
Sample Date	**3/19/2014**	**3/18/2014**	**3/19/2014**	**3/18/2014**
Volatile Organic Compounds (µg/L)				
Acetone	20 U	21 U	20 U	20 U
Benzene	0.50 U	0.50 U	0.50 U	0.50 U
Bromobenzene	0.50 U	0.50 U	0.50 U	0.50 U
Bromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	0.50 U	0.50 U	0.50 U	0.50 U
n-Butylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
sec-Butylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
tert-Butylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	**0.54 J**	**1.5**	**0.81 J**	0.50 U
o-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U
p-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	0.50 U	**0.88 J**	0.50 U	0.50 U
1,1-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dibromo-3-chloropropane	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
2,2-Dichloropropane	0.50 U	0.50 UJ	0.50 U	0.50 UJ
Dibromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Dichlorodifluoromethane	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	0.50 U	0.50 U	**1.5**	**0.62 J**
cis-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
m-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
o-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
p-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,2-Dichloroethene	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
p-Isopropyltoluene	0.50 U	0.50 U	0.50 U	0.50 U
4-Methyl-2-pentanone	2.0 U	2.0 U	2.0 U	2.0 U
Methyl bromide	1.0 U	1.0 U	1.0 U	1.0 U
Methyl chloride	1.0 U	1.0 U	1.0 U	1.0 U

Table 3.3a (Continued)
Laboratory Analytical Summary
March 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**354-01-27**	**354-99-09**	**TSO292-01**	**TSO292-02**
Sample Date	**3/19/2014**	**3/18/2014**	**3/19/2014**	**3/18/2014**
Volatile Organic Compounds (µg/L)				
Methylene bromide	0.50 U	0.50 U	0.50 U	0.50 U
Methylene chloride	4.0 U	4.0 U	4.0 U	4.0 U
Methyl ethyl ketone	4.0 U	4.0 U	4.0 U	4.0 U
Methyl Tert Butyl Ether	0.50 U	0.50 U	0.50 U	0.50 U
Naphthalene	2.0 U	2.0 U	2.0 U	2.0 U
n-Propylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
Styrene	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	0.75 U	0.75 U	0.75 U	0.75 U
1,2,3-Trichloropropane	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	0.75 U	0.75 U	0.75 U	0.75 U
1,2,4-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
1,3,5-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	**94.1**	**33.1**	**57.0**	0.50 U
Toluene	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	**1.4**	**0.45 J**	**4.3**	0.50 U
Trichlorofluoromethane	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	0.50 U	0.50 U	0.50 U	0.50 U
m,p-Xylene	1.0 U	1.0 U	1.0 U	1.0 U
o-Xylene	0.50 U	0.50 U	0.50 U	0.50 U
Natural Attenuation Parameters				
Methane (µg/L)	**7.7**	**7.6**	**10.8**	**8.9**
Ethane (µg/L)	0.50 U	0.50 U	0.50 U	0.50 U
Ethene (µg/L)	0.50 U	0.50 U	0.50 U	0.50 U
Total Organic Carbon (mg/L)	**1.0**	**2.0**	**1.7**	**4.3**
Sulfide (mg/L)	**0.45 J**	**0.27 J**	**0.69 J**	**0.51 J**
Alkalinity, Total as CaCO3 (mg/L)	**301**	**293**	**325**	**513**
Chloride (mg/L)	**47.1**	**211**	**344**	**250**
Nitrogen, Nitrite (a) (mg/L)	0.10 U	0.25 U	11.3	0.25 U
Nitrogen, Nitrate (mg/L)	**8.7**	**14.4**	**12.7**	0.25 U
Sulfate (a) (mg/L)	**48.7**	**90.9 J**	**111**	**6.2 J**

Notes:

When duplicate samples were collected the maximum value was reported.

Bold = Compound detected above the method detection limit.

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

mg/L = milligrams per liter

NA = not applicable

µg/L = micrograms per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.3b
Laboratory Analytical Summary
July 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**354-01-27**	**354-99-09**	**TSO292-01**	**TSO292-02**
Sample Date	**7/16/2014**	**7/16/2014**	**7/16/2014**	**7/16/2014**
Volatile Organic Compounds (μg/L)				
Acetone	20 UJ	20 UJ	20 UJ	20 UJ
Benzene	0.50 U	0.50 U	**0.58 J**	**2.7**
Bromobenzene	0.50 U	0.50 U	0.50 U	0.50 U
Bromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	0.50 U	0.50 U	0.50 U	0.50 UJ
n-Butylbenzene	0.50 U	0.50 U	0.50 U	**8.5**
sec-Butylbenzene	0.50 U	0.50 U	0.50 U	**8.2**
tert-Butylbenzene	0.50 U	0.50 U	0.50 U	**3.5**
Chlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	1.0 U	1.0 U	1.0 U	**0.84 J**
Chloroform	**0.67 J**	**1.2 J**	**0.77 J**	0.50 U
o-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U
p-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	0.50 U	**0.48 J**	0.50 U	0.50 U
1,1-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dibromo-3-chloropropane	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
2,2-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U
Dichlorodifluoromethane	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	0.50 U	0.50 U	**1.1**	**3.3**
cis-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
m-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
o-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
p-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,2-Dichloroethene	0.50 U	0.50 U	0.50 U	**0.41 J**
trans-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	0.50 UJ	0.50 U	0.50 U	**3.4**
p-Isopropyltoluene	0.50 U	0.50 U	0.50 U	0.50 U
4-Methyl-2-pentanone	2.0 U	2.0 U	2.0 U	2.0 U
Methyl bromide	1.0 U	1.0 U	1.0 U	1.0 U
Methyl chloride	1.0 U	1.0 U	1.0 U	**1.6**
Methylene bromide	0.50 U	0.50 U	0.50 U	0.50 U
Methylene chloride	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ
Methyl ethyl ketone	4.0 U	4.0 U	4.0 U	4.0 U
Methyl Tert Butyl Ether	0.50 U	0.50 U	0.50 U	0.50 U
Naphthalene	2.0 U	2.0 U	2.0 U	2.0 U
n-Propylbenzene	0.50 U	0.50 U	0.50 U	**0.61 J**
Styrene	0.50 U	0.50 U	0.50 U	0.50 U

Table 3.3b (Continued)
Laboratory Analytical Summary
July 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**354-01-27**	**354-99-09**	**TSO292-01**	**TSO292-02**
Sample Date	**7/16/2014**	**7/16/2014**	**7/16/2014**	**7/16/2014**
Volatile Organic Compounds (μg/L)				
1,1,1,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	0.75 U	0.75 U	0.75 U	0.75 U
1,2,3-Trichloropropane	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	0.75 U	0.75 U	0.75 U	0.75 U
1,2,4-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
1,3,5-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	**80.5**	**27.3**	**50.1**	0.50 U
Toluene	0.50 U	0.50 U	0.50 U	**0.21 J**
Trichloroethene	**1.1**	**0.31 J**	**4.6**	0.50 U
Trichlorofluoromethane	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	0.50 U	0.50 U	0.50 U	0.50 U
m,p-Xylene	1.0 U	1.0 U	1.0 U	**0.75 J**
o-Xylene	0.50 U	0.50 U	0.50 U	0.50 U
Natural Attenuation Parameters				
Methane (μg/L)	0.25 U	0.25 U	**1.3**	**5.4**
Ethane (μg/L)	0.50 U	0.50 U	0.50 U	0.50 U
Ethene (μg/L)	0.50 U	0.50 U	0.50 U	0.50 U
Total Organic Carbon (mg/L)	**1.3**	**1.2 J**	**1.4 J**	**2.8 J**
Sulfide (mg/L)	**0.24 J**	0.23 U	0.24 U	**0.32 J**
Alkalinity, Total as CaCO3 (mg/L)	NA	NA	NA	NA
Chloride (mg/L)	**46.3**	**283**	**224**	**72.3**
Nitrogen, Nitrite (a) (mg/L)	0.050 UJ	0.25 UJ	0.25 UJ	0.25 UJ
Nitrogen, Nitrate (mg/L)	**6.0 J**	**13.8 J**	**7.4 J**	0.25 UJ
Sulfate (a) (mg/L)	**46.7**	**78.3**	**85.0**	**8.7 J**

Notes:

When duplicate samples were collected the maximum value was reported.

Bold = Compound detected above the method detection limit.

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

mg/L = milligrams per liter

NA = not applicable

μg/L = micrograms per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.4a
Summary of VOCs Detected and Natural Attenuation Parameters
March 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**MCL[1]**	**KDHE RSK[2]**	**354-01-27**	**354-99-09**	**TS0292-01**	**TS0292-01-D**	**TS0292-02**
Sample Date			**3/19/2014**	**3/18/2014**	**3/19/2014**	**3/19/2014**	**3/18/2014**
COC Volatile Organic Compounds (μg/L)							
cis-1,2-Dichloroethene	70	70	0.50 U	0.50 U	**1.5**	**1.4**	**0.62 J**
Tetrachloroethene	5	5	**94.1**	**33.1**	**56.6**	**57.0**	0.50 U
Trichloroethene	5	5	**1.4**	**0.45 J**	**4.3**	**4.1**	0.50 U
Non-COC Volatile Organic Compounds (μg/L)							
Carbon tetrachloride	5	5	0.50 U	**0.88 J**	0.50 U	0.50 U	0.50 U
Chloroform	80*	80*	**0.54 J**	**1.5**	**0.76 J**	**0.81 J**	0.50 U
Natural Attenuation Parameters (mg/L)							
Alkalinity	-	-	**301**	**293**	**299**	**325**	**513**
Chloride	-	-	**47.1**	**211**	**344**	**337**	**250**
Methane	-	-	**7.7**	**7.6**	**10.8**	**10.7**	**8.9**
Nitrogen, Nitrate	10	-	**8.7**	**14.4**	**12.7**	0.25 U	0.25 U
Sulfate	-	-	**48.7**	**90.9 J**	**111**	**106**	**6.2 J**
Sulfide	-	-	**0.45 J**	**0.27 J**	0.22 U	**0.69 J**	**0.51 J**
Total Organic Carbon	-	-	**1.0**	**2.0**	**1.7**	**1.6**	**4.3**

Notes:

[1] EPA Regional Screening Level Summary Table (TR=1E-6, HQ=1) January 2015.

[2] Groundwater, Residential Scenario, Risk-Based Standards for Kansas RSK Manual – 5th Version, October 2010 with revised tables from March 2014.

Bold = Compound detected above the method detection limit.

Shaded = Compound above MCL limit.

* 80 μg/L is the MCL for total trihalomethanes.

\- = no screening value for analyte.

COC = chemical of concern

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

KDHE RSK = Kansas Department of Health and Environment Risk Based Standards for Kansas

MCL = maximum contaminant level

mg/L = milligrams per liter

μg/L = micrograms per liter

U = Not detected. The associated value indicates the analyte limit of detection.

Table 3.4b
Summary of VOCs Detected and Natural Attenuation Parameters
July 2014 Groundwater Sampling Event
OU 005, FTR-031, Fort Riley, Kansas

Well Location	**MCL[1]**	**KDHE RSK[2]**	**354-01-27**	**354-01-27-D**	**354-99-09**	**TS0292-01**	**TS0292-02**
Sample Date			**7/16/2014**	**7/16/2014**	**7/16/2014**	**7/16/2014**	**7/16/2014**
COC Volatile Organic Compounds (μg/L)							
Benzene	5	5	0.50 U	0.50 U	0.50 U	**0.58 J**	**2.7**
cis-1,2-Dichloroethene	70	70	0.50 U	0.50 U	0.50 U	**1.1**	**3.3**
Tetrachloroethene	5	5	**80.5**	**79.9**	**27.3**	**50.1**	0.50 U
Trichloroethene	5	5	**1.1**	**1.1**	**0.31 J**	**4.6**	0.50 U
Non-COC Volatile Organic Compounds (μg/L)							
n-Butylbenzene	-	169	0.50 U	0.50 U	0.50 U	0.50 U	**8.5**
sec-Butylbenzene	-	305	0.50 U	0.50 U	0.50 U	0.50 U	**8.2**
tert-Butylbenzene	-	-	0.50 U	0.50 U	0.50 U	0.50 U	**3.5**
Carbon tetrachloride	5	5	0.50 U	0.50 U	**0.48 J**	0.50 U	0.50 U
Chloroethane	-	-	1.0 U	1.0 U	1.0 U	1.0 U	**0.84 J**
Chloroform	80*	80*	**0.64 J**	**0.67 J**	**1.2**	**0.77 J**	0.50 U
trans-1,2-Dichloroethene	100	100	0.50 U	0.50 U	0.50 U	0.50 U	**0.41 J**
Isopropylbenzene	-	-	0.50 U	0.50 U	0.50 U	0.50 U	**3.4**
Methyl Chloride	-	-	1.0 U	1.0 U	1.0 U	1.0 U	**1.6**
n-Propylbenzene	-	660	0.50 U	0.50 U	0.50 U	0.50 U	**0.61 J**
Toluene	1,000	1,000	0.50 U	0.50 U	0.50 U	0.50 U	**0.21 J**
m,p-Xylene	-	190	1.0 U	1.0 U	1.0 U	1.0 U	**0.75 J**
Natural Attenuation Parameters (mg/L)							
Chloride	-	-	**44.6**	**46.3**	**283**	**224**	**72.3**
Methane	-	-	0.25 U	0.25 U	0.25 U	**1.3**	**5.4**
Nitrogen, Nitrate	10	-	**6.0 J**	**6.0**	**13.8 J**	**7.4 J**	0.25 UJ
Sulfate	-	-	**45.2**	**46.7**	**78.3**	**85.0**	**8.7 J**
Sulfide	-	-	0.24 U	**0.24 J**	0.23 U	0.24U	**0.32 J**
Total Organic Carbon	-	-	**1.2 J**	**1.3**	**1.2 J**	**1.4 J**	**2.8 J**

Notes:

[1] EPA Regional Screening Level Summary Table (TR=1E-6, HQ=1) January 2015

[2] Groundwater, Residential Scenario, Risk-Based Standards for Kansas RSK Manual – 5th Version, October 2010 with revised tables from March 2014.

Bold = Compound detected above the method detection limit.

Shaded = Compound above MCL limit.

* 80 μg/L is the MCL for total trihalomethanes

\- = no screening value for analyte

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

KDHE RSK = Kansas Department of Health and Environment Risk Based Standards for Kansas

MCL = maximum contaminant level

mg/L = milligrams per liter

μg/L = micrograms per liter

U = Not detected. The associated value indicates the analyte limit of detection.

Table 3.5a
Groundwater MNA Parameters
March 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**Favorable Geochemical Conditions**	**354-01-27**	**354-99-09**	**TS0292-01**	**TS0292-02**
Sample Date		**3/19/2014**	**3/18/2014**	**3/19/2014**	**3/18/2014**
Temperature (°C)	>20	14.18	14.73	14.72	14.34
pH	>5 <9	**6.95**	**6.81**	**6.64**	**6.75**
Dissolved Oxygen (mg/L)	<0.5	5.63	5.80	1.19	1.04
Oxygen Reduction Potential (mV)	<50	205	119.9	121.1	**-81.3**
Ferrous Iron (mg/L)	>1	0.05	0.04	0.05	**1.29**
Methane (μg/L)	>500	7.7	7.6	10.8	8.9
Ethane (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.50 U
Ethene (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.50 U
Alkalinity (mg/L)	>2x Background	301	293	325	513
Chloride (mg/L)	>2x Background	47.1	**211**	**344**	**250**
Nitrate, as N (mg/L)	<1	8.7	14.4	12.7	**0.25 U**
Sulfate (mg/L)	<20	48.7	90.9J	111	**6.2 J**
Sulfide (mg/L)	>1	0.45 J	0.27 J	0.69 J	0.51 J
Total Organic Carbon (mg/L)	>20	1.0	2.0	1.7	4.3

Notes:

Bold indicates favorable geochemical conditions for natural attenuation of contaminants.

Background well is 354-01-28, chloride 29 mg/L and alkalinity 378 mg/L measured on March 4, 2009.

< = less than

> = greater than

°C = degrees Celsius

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

mg/L = milligrams per liter

mV = millivolts

μg/L = microgram per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.5b
Groundwater MNA Parameters
July 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**Favorable Geochemical Conditions**	**354-01-27**	**354-99-09**	**TS0292-01**	**TS0292-02**
Sample Date		**7/16/2014**	**7/16/2014**	**7/16/2014**	**7/16/2014**
Temperature (°C)	>20	18.25	15.74	18.42	19.31
pH	>5 <9	**6.59**	**6.53**	**6.58**	**6.55**
Dissolved Oxygen (mg/L)	<0.5	6.4	5.86	0.63	1.3
Oxygen Reduction Potential (mV)	<50	135.8	122.4	62.8	**-75.4**
Ferrous Iron (mg/L)	>1	0	0.03	0	**1.66**
Methane (μg/L)	>500	0.25 U	0.25 U	1.3	5.4
Ethane (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.50 U
Ethene (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.50 U
Chloride (mg/L)	>2x Background	44.6	**283**	**224**	**72.3**
Nitrate, as N (mg/L)	<1	6 J	13.8 J	7.4 J	**0.25 UJ**
Sulfate (mg/L)	<20	45.2	78.3	85.0	**8.7 J**
Sulfide (mg/L)	>1	0.24 U	0.23 U	0.24U	0.32 J
Total Organic Carbon (mg/L)	>20	1.2 J	1.2 J	1.4 J	2.8 J

Notes:

Bold indicates favorable geochemical conditions for natural attenuation of contaminants.

Background well is 354-01-28, chloride 29 mg/L and alkalinity 378 mg/L measured on March 4, 2009.

< = less than

> = greater than

°C = degrees Celsius

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

mg/L = milligrams per liter

mV = millivolts

μg/L = microgram per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.6
Historical Laboratory Analytical Results
March and July 2014 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	354-01-27		354-99-09		TS0292-01			TS0292-02
Sample Date*	**PCE**	**TCE**	**PCE**	**TCE**	**PCE**	**TCE**	**Benzene**	**Benzene**
Feb-00	NA	NA	**25.1**	0.6 U	**69.3**	3.2	3.5	**14.6**
Jul-00	NA	NA	**96.8**	1.4	**75.9**	3.3	3.2	**17.5**
Oct-00	NA	NA	**75.9**	1.2	**56.8**	3.6	4.2	**25.3**
Mar-01	NA	NA	**53.2**	1	**66.5**	3.6	0.9	**15.2**
Oct-01	**181**	2.6	**58.2**	1.1	**44.2**	2.7	3	**17.8**
Jan-02	**208**	2.8	**50.8**	0.8	**27.9**	2.2	0.4 U	**31**
Apr-02	**166**	2.5	**29.3**	0.6 U	**33**	2.2	0.4 U	**37.4**
Jul-02	**179**	3.2	**27.5**	0.6 U	**39**	2.7	0.4 U	**40.3**
Mar-03	**180**	1.9	**31.7**	0.7	**32.6**	3	0.4 U	**42.6**
Sep-03	**121**	1.7	**27.7**	0.7	**21.6**	3	0.7	**18.8**
Apr-04	**95.9**	1.3	**60**	1.2	**32.1**	2.7	0.4 U	**7.5**
Oct-04	**71.7**	1.2	**37.8**	0.7	**24.8**	3	0.4 U	**25**
Apr-05	**98.5**	1	**27.3**	0.6 U	**55.8**	3.8	0.4 U	**24**
Sep-06	**96.6**	0.9	**75.9**	1.1	**23.3**	2.8	9.5	**12.3**
Apr-07	**82.9**	1.1	**49**	0.7	**43**	3.9	0.5 U	**10**
Mar-08	**76.1**	1	**39.4**	0.6 U	**60.4**	5.7	0.5	**7.8**
Mar-09	**21.1**	0.6 J	**34.5**	0.6 U	**49.5**	2.8	0.5 U	4.3
Aug-11	**28**	1.0 U	**13**	1.0 U	**20**	2.1	0.2 J	**7.9**
Apr-12	**8.9**	1.0 U	**8.1**	1.0 U	**13**	1.2	1.0 U	3.3
Mar-14	**94.1**	1.4	**33.1**	0.45 J	**56.6**	4.3	0.50 U	0.50 U
Jul-14	**80.5**	1.1	**27.3**	0.31 J	**50.1**	4.6	0.58 J	2.7

Notes:

* Dates are in Month-Year

Bold indicates analyte concentration exceeds MCL (PCE = 5 μg/L, TCE = 5 μg/L, Benzene = 5 μg/L).

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

NA = not analyzed

PCE = Tetrachloroethene

TCE = Trichloroethene

U = Not detected. The associated number indicates the analyte limit of detection.

μg/L = micrograms per liter

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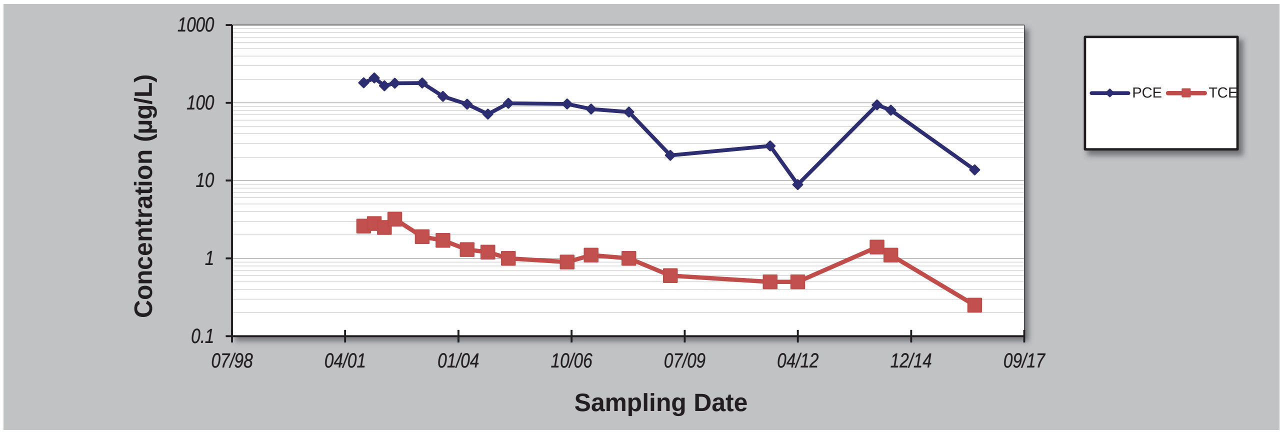
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**
Job ID: **FTRI-031**
Constituent: **354-01-27**
Concentration Units: **μg/L**

	Sampling Point ID:	**PCE**	**TCE**					
Sampling Event	Sampling Date	354-01-27 CONCENTRATION (µg/L)						
1	10/01/01	**181**	**2.6**					
2	01/01/02	**208**	**2.8**					
3	04/01/02	**166**	**2.5**					
4	07/01/02	**179**	**3.2**					
5	03/01/03	**180**	**1.9**					
6	09/01/03	**121**	**1.7**					
7	04/01/04	**95.9**	**1.3**					
8	10/01/04	**71.7**	**1.2**					
9	04/01/05	**98.5**	**1**					
10	09/01/06	**96.6**	**0.9**					
11	04/01/07	**82.9**	**1.1**					
12	03/01/08	**76.1**	**1**					
13	03/01/09	**21.1**	**0.6**					
14	08/01/11	**28**	0.5					
15	04/01/12	**8.9**	0.5					
16	03/01/14	**94.1**	**1.4**					
17	07/01/14	**80.5**	**1.1**					
18	11-Jul-16	**13.7**	0.25					
19								
20								
Coefficient of Variation:		**0.62**	**0.61**					
Mann-Kendall Statistic (S):		**-107**	**-106**					
Confidence Factor:		**>99.9%**	**>99.9%**					
Concentration Trend:		Decreasing	Decreasing					



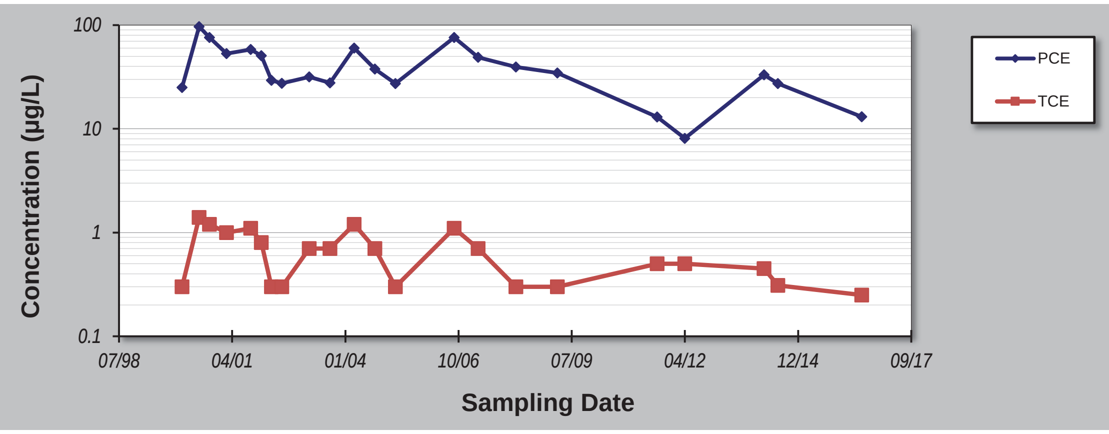
Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 15-Aug-16
Facility Name: HydroGeoLogic, Inc.
Conducted By: ECU
Job ID: FTRI-031
Constituent: 354-99-09
Concentration Units: µg/L

	Sampling Point ID:	PCE	TCE					
Sampling Event	Sampling Date	354-99-09 CONCENTRATION (µg/L)						
1	2/1/2000	25.1	0.3					
2	7/1/2000	96.8	1.4					
3	10/1/2000	75.9	1.2					
4	03/01/01	53.2	1					
5	10/01/01	58.2	1.1					
6	01/01/02	50.8	0.8					
7	04/01/02	29.3	0.3					
8	07/01/02	27.5	0.3					
9	03/01/03	31.7	0.7					
10	09/01/03	27.7	0.7					
11	04/01/04	60	1.2					
12	10/01/04	37.8	0.7					
13	04/01/05	27.3	0.3					
14	09/01/06	75.9	1.1					
15	04/01/07	49	0.7					
16	03/01/08	39.4	0.3					
17	03/01/09	34.5	0.3					
18	08/01/11	13	0.5					
19	04/01/12	8.1	0.5					
20	03/01/14	33.1	0.45					
21	07/01/14	27.3	0.31					
22	7/11/2016	13.1	0.25					
23								
24								
25								
	Coefficient of Variation:	0.55	0.56					
	Mann-Kendall Statistic (S):	-87	-87					
	Confidence Factor:	99.3%	99.3%					
	Concentration Trend:	Decreasing	Decreasing					



Notes:

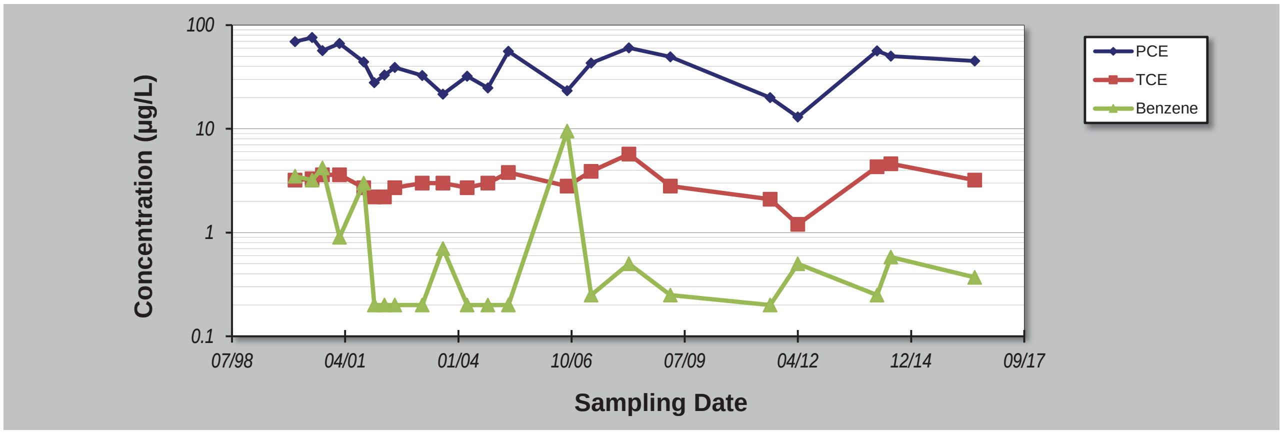
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **TS0292-01**
Concentration Units: **µg/L**

	Sampling Point ID:	PCE	TCE	Benzene				
Sampling Event	Sampling Date	TS0292-01 CONCENTRATION (µg/L)						
1	2/1/2000	69.3	3.2	3.5				
2	7/1/2000	75.9	3.3	3.2				
3	10/1/2000	56.8	3.6	4.2				
4	03/01/01	66.5	3.6	0.9				
5	10/01/01	44.2	2.7	3				
6	01/01/02	27.9	2.2	0.2				
7	04/01/02	33	2.2	0.2				
8	07/01/02	39	2.7	0.2				
9	03/01/03	32.6	3	0.2				
10	09/01/03	21.6	3	0.7				
11	04/01/04	32.1	2.7	0.2				
12	10/01/04	24.8	3	0.2				
13	04/01/05	55.8	3.8	0.2				
14	09/01/06	23.3	2.8	9.5				
15	04/01/07	43	3.9	0.25				
16	03/01/08	60.4	5.7	0.5				
17	03/01/09	49.5	2.8	0.25				
18	08/01/11	20	2.1	0.2				
19	04/01/12	13	1.2	0.5				
20	03/01/14	56.6	4.3	0.25				
21	07/01/14	50.1	4.6	0.58				
22	11-Jul-16	45.1	3.2	0.37				
23								
24								
25								
	Coefficient of Variation:	0.41	0.30	1.66				
	Mann-Kendall Statistic (S):	-57	23	-31				
	Confidence Factor:	94.2%	73.0%	79.9%				
	Concentration Trend:	Prob. Decreasing	No Trend	No Trend				



Notes:

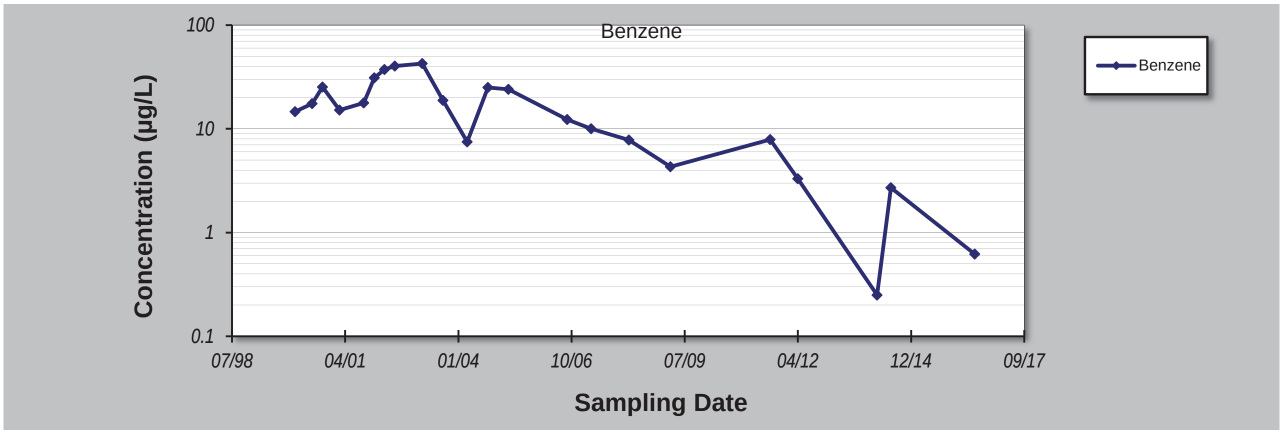
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **TS0292-02**
Concentration Units: **µg/L**

	Sampling Point ID:	**Benzene**						
Sampling Event	Sampling Date	TS0292-02 CONCENTRATION (µg/L)						
1	2/1/2000	**14.6**						
2	7/1/2000	**17.5**						
3	10/1/2000	**25.3**						
4	03/01/01	**15.2**						
5	10/01/01	**17.8**						
6	01/01/02	**31**						
7	04/01/02	**37.4**						
8	07/01/02	**40.3**						
9	03/01/03	**42.6**						
10	09/01/03	**18.8**						
11	04/01/04	**7.5**						
12	10/01/04	**25**						
13	04/01/05	**24**						
14	09/01/06	**12.3**						
15	04/01/07	**10**						
16	03/01/08	**7.8**						
17	03/01/09	**4.3**						
18	08/01/11	**7.9**						
19	04/01/12	**3.3**						
20	03/01/14	0.25						
21	07/01/14	**2.7**						
22	7/11/2016	**0.62**						
23								
24								
25								
	Coefficient of Variation:	**0.77**						
	Mann-Kendall Statistic (S):	**-117**						
	Confidence Factor:	**>99.9%**						
	Concentration Trend:	Decreasing						



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

VISL Calculations for Maximum Value from Table 3-1 for Commercial Land Use.

Benzene and carbon tetra chloride were not considered present. Cis-1,1-dichoroethene was not available in VISL so was not included in estimates.

OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.4, June 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ
71-43-2	Benzene	5.0E-01	1.13E-01	7.2E-08	8.6E-04
67-66-3	Chloroform	1.8E+00	2.70E-01	5.1E-07	6.3E-04
127-18-4	Tetrachloroethylene	4.3E+01	3.11E+01	6.6E-07	1.8E-01
79-01-6	Trichloroethylene	3.2E+00	1.29E+00	4.3E-07	1.5E-01

Inhalation Unit Risk IUR ($(ug/m^3)^{-1}$)	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i
7.80E-06	I	3.00E-02	I	
2.30E-05	I	9.80E-02	A	
2.60E-07	I	4.00E-02	I	
4.10E-06	I	2.00E-03	I	Mut

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Trichloroethylene	mIURTCE_R_GW	1.00E-06	IURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride

See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.

OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.4, June 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration	Calculated Indoor Air Concentration	VI Carcinogenic Risk	VI Hazard
		Cgw	Cia	CR	HQ
		(ug/L)	(ug/m^3)		

Inhalation Unit Risk	IUR Source*	Reference Concentration	RFC Source*	Mutagenic Indicator
IUR		RfC		
(ug/m^3)$^{-1}$		(mg/m^3)		i

Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

VISL Calculations for Maximum Value from 2017 Summary Report for Terrace Wells for the Commercial Land Use.

OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.4, June 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ
127-18-4	Tetrachloroethylene	6.6E+01	4.77E+01	**1.0E-06**	2.7E-01
79-01-6	Trichloroethylene	2.2E+00	8.86E-01	3.0E-07	1.0E-01

Inhalation Unit Risk IUR $(ug/m^3)^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i
2.60E-07	I	4.00E-02	I	
4.10E-06	I	2.00E-03	I	Mut

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_GW	1.00E-06	IURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride

See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.
Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

VISL Calculations for Maximum Value from Table 3-1 for Commercial Land Use.

Benzene and carbon tetra chloride were not considered present. Cis-1,1-dichoroethene was not available in VISL so was not included in estimates.

OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.4, June 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

		Site Groundwater Concentration	Calculated Indoor Air Concentration	VI Carcinogenic Risk	VI Hazard	Inhalation Unit Risk	IUR Source*	Reference Concentration	RFC Source*	Mutagenic Indicator
		Cgw	Cia	CR	HQ	IUR		RfC		
CAS	Chemical Name	(ug/L)	(ug/m^3)			$(ug/m^3)^{-1}$		(mg/m^3)		i
71-43-2	Benzene	5.0E-01	1.13E-01	7.2E-08	8.6E-04	7.80E-06	I	3.00E-02	I	
67-66-3	Chloroform	1.8E+00	2.70E-01	5.1E-07	6.3E-04	2.30E-05	I	9.80E-02	A	
127-18-4	Tetrachloroethylene	4.3E+01	3.11E+01	6.6E-07	1.8E-01	2.60E-07	I	4.00E-02	I	
79-01-6	Trichloroethylene	3.2E+00	1.29E+00	4.3E-07	1.5E-01	4.10E-06	I	2.00E-03	I	Mut

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_GW	1.00E-06	IURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals — The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride — See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

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OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.4, June 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
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Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration	Calculated Indoor Air Concentration	VI Carcinogenic Risk	VI Hazard
		Cgw	Cia	CR	HQ
		(ug/L)	(ug/m^3)		

Inhalation Unit Risk	IUR Source*	Reference Concentration	RFC Source*	Mutagenic Indicator
IUR		RfC		
(ug/m^3)$^{-1}$		(mg/m^3)		i

Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

OCT 28 2013

MEMORANDUM

SUBJECT: Concurrence on Attached Five Year Review Addendum, Fort Riley, Kansas

FROM: Amer Safadi, Remedial Project Manager
Missouri/Kansas Remedial Branch

THRU: Jeff Field, Chief
Missouri/Kansas Remedial Branch

TO: Cecilia Tapia, Director
Superfund Division

Please review the attached Five Year Review Addendum and Technical Memorandum (TM) for the site at Fort Riley, Kansas. The reason for this addendum is to reevaluate the protectiveness of human health and the environment at Operable Unit 5 (OU05) which was deferred due to potential vapor intrusion exposure. The MNA and ICs associated with the groundwater are effectively controlling groundwater exposure pathways. However it was not certain whether the vapor intrusion exposure pathway that could potentially result in unacceptable long-term risks at building 367 was complete or whether it was adequately controlled. The installation with the approval of the EPA determined that mitigation of the potential risk (soil removal) is the approach to follow in this situation as opposed to further investigations. It was also agreed to place the ICs related to the vapor intrusion in the land use control plan.

A Technical Memorandum was developed to address these concerns. The potential source was removed in a remedial action and the area backfilled with clean soil and repaved. Based on this action and other factors such as lack of human presence at the site, and the continuous decrease of groundwater concentrations in nearby monitoring wells, the data presented in the TM suggests that a vapor intrusion exposure in this building does not support a potential threat to human health. In addition, the Real Property Master Plan will be updated to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions and/or tenants are changed.

If you have any questions regarding this Addendum or Technical Memorandum, please contact Amer Safadi at extension 7825.

Attachments

Approve__________ Date 10-28-13

Addendum to the Third Five-Year Review Report for Fort Riley, Kansas, dated 27 September 2012

A Five-Year Review addendum is generally completed for remedies where the protectiveness determination is deferred until further information is obtained. When deferring protectiveness in the Five-Year Review report, EPA typically provides a timeframe for when the information will be obtained and a protectiveness statement can be made. This document provides progress since the Five-Year Review and protectiveness determinations for the remedies where the statement was deferred in the 27 September 2012 Five-Year Review.

The Five-Year Review report (Report) for Fort Riley in Geary, Clay and Riley Counties near Junction City, Kansas, was signed by Herbert J. Abel, Chief, Environmental Division, Directorate of Public Works, US Army, Fort Riley on 20 September 2012, and by Cecilia Tapia, Director, Superfund Division, US Environmental Protection Agency on 27 September 2012. The protectiveness statements outlined in the Report were as follows:

OU 001, Southwest Funston Landfill Protectiveness Statement: The remedy at the SFL (controlling future land use and site access through institutional controls; stabilizing the Kansas River bank along the southern perimeter of the landfill; repairing and improving the existing native vegetation and soil cover; prohibiting the future use of site groundwater; and implementing a long-term groundwater monitoring program) is currently protective of human health and the environment and will continue to be protective during long-term management and care. There are no complete soil or groundwater exposure pathways that presently result in unacceptable risks at the site.

OU 003, Dry Cleaning Facilities Area Protectiveness Statement: The remedy at the DCFA Site (OU 003), Monitored Natural Attenuation with institutional controls, is currently protective of human health and the environment, and will continue to be protective long-term. Monitoring of natural attenuation is showing that COCs in groundwater are decreasing. Institutional controls, as documented in the RPMP and RD/RA Plan are blocking exposure pathways that could potentially result in unacceptable risks.

OU 005, 354 Area Solvent Detections Protectiveness Statement: The protectiveness determination of the remedy at the 354 Site (OU 005), Monitored Natural Attenuation with institutional controls, is deferred pending additional assessment. MNA and ICs associated with groundwater are effectively controlling groundwater exposure pathways. However it is not certain whether the vapor intrusion exposure pathway that could potentially result in unacceptable long-term risks at Building 367 is complete, or if so, whether it is adequately controlled. The installation is pursuing a strategy to mitigate the potential pathway. Within one year a Technical Memorandum will be prepared by the Army and coordinated with EPA to identify site conditions and site management procedures necessary to ensure long term protectiveness with respect to the vapor intrusion pathway.

This addendum addresses the Protectiveness Statement for OU 005 only.

Progress Since the Five-Year Review Completion Date

OU 005, 354 Area Solvent Detections Issues and Recommendations Identified in the Five-Year Review:

Issue 1: Comparison of soil vapor data at OU 005 to current screening values in accordance with the most recent guidance (EPA 2002) for vapor intrusion suggests that there is a potential risk from vapor intrusion at

Building 367. This conflicts with the findings of the RI for OU 005, which concluded there was no unacceptable vapor intrusion risk. A 2004 source removal, the leaky nature of the structure, and the use pattern of the building suggest that potential risk is likely much less than the conservative screening indicates.

Recommendation 1: The installation has determined that direct mitigation of the potential risk is a cost-effective approach to the issue as opposed to further investigations. Several mitigating factors are already in place as they are inherent in the condition and use of the building. The Army should prepare a Technical Memorandum for EPA review and approval to specify all site conditions and procedures that must be in place to mitigate potential vapor intrusion exposure. The document should include all site history, investigation data, and site use information necessary to support the effectiveness of mitigation.

Issue 2: Institutional controls (IC) related to vapor intrusion at OU 005 are described in a letter to the USEPA; however, these ICs are not currently included in the Land Use Control Plan (LUCP).

Recommendation 2: If it is confirmed that ICs are required, update the LUCP to include the IC requirements contained in the letter to the USEPA, and ensure that the ICs are modified, implemented and updated as appropriate.

Resolution: A Technical Memorandum (attached) was developed to address the concern that there may be a potential vapor intrusion issue that is affiliated with Building 367 within the 354 Area Solvent Detections Operable Unit 005 (OU 005) (354) at Fort Riley, Kansas. The Technical Memorandum concluded with the following Summary and Recommendations:

> "The concern was raised that the site and its circumstances might necessitate a vapor intrusion study based on two values obtained in a 2004 soil-gas study. The data presented in the preceding discussion section are indicative of a lack of a reasonable potential for a vapor intrusion issue to exist for the building.
>
> The potential source was removed in a remedial action and the area backfilled with clean soil and re-paved, the ground-water concentrations in nearby monitoring wells are continuing to decrease, and the building's lack of a long-term or continuous human presence supports the contention that no evidence supports the existence of a pathway that would dictate the need to conduct any further studies.
>
> The decrease in the level of toxicity of PCE, the building's many penetrations that do not permit accumulation of vapors, and the lack of potential that the building will be used to house office spaces or other enclosed sensitive functions are further substantiation that there is no supportable reason to be concerned about vapor intrusion or build up.
>
> Based on the data that are presented in the technical memorandum, the physical criteria at the site with regard to the building, its structure and conditions, the 8-inch thick pavement, soil characteristics, and the removal of the contaminated soils, a vapor intrusion pathway cannot be demonstrated to be a viable consideration. The installation does not find it an acceptable approach to expend funds for a study that will fail to demonstrate any potential for vapor accumulation or intrusion from the site contaminants.

Based upon the available information discussed in this memorandum, vapor intrusion exposures in this building do not present a potentially significant threat to human health. The building has signs posted to advise that there is a potential for vapor intrusion and provides the directions by which the potential exposure can be avoided. The Real Property Master Plan will be updated to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions, and/or tenants are changed.

Therefore, the protectiveness as defined in the Record of Decision for the 354 Area Solvent Detections (Operable Unit 005) is still effective and should not be considered deferred based on the potential for vapor intrusion."

New Issues and Recommendations

Issue 1 above has been resolved with the production of the Technical Memorandum. Issue 2 will be resolved upon completion of the next revision to the Real Property Master Plan (RPMP). The recommendation is revised as below.

OU(s): OU 005 354 Area Solvent Detections	**Issue Category: Institutional Controls**			
	Issue: Institutional controls (IC) related to vapor intrusion at OU 005 are described in a letter to the USEPA; however, these ICs are not currently included in the Real Property Master Plan.			
	Recommendation: The Real Property Master Plan will be updated in its next revision to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions, and/or tenants are changed, in which case the US EPA recommends that sub-slab testing be accomplished.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2016

Protectiveness Statements

Based on new information and/or actions taken since the Five-Year Review completion date, the protectiveness statement for OU 005 is being revised as follows:

OU 005, 354 Area Solvent Detections Protectiveness Statement: The remedy at the 354 Site (OU 005), Monitored Natural Attenuation with institutional controls, is currently protective of human health and the environment. For the remedy to remain protective in the long-term, the Real Property Master Plan will be updated to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions, and/or tenants are changed, in which case the US EPA recommends that sub-slab testing be accomplished.

Next Five-Year Review

The next five-year review will be completed on September 30, 2017, five years after the due date of the last five-year review report.

for Dirk Clement Date 23 Sept 2013

Herbert J. Abel
Chief, Environmental Division
Directorate of Public Works
US Army, Fort Riley

Attachment:
Vapor Intrusion Technical Memorandum
Addendum to the 3rd Five-Year Review Report for Fort Riley, Kansas
June 2013

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DRAFT
JULY 2016 LONG-TERM MONITORING REPORT
354 AREA SOLVENT DETECTIONS OU 005
(FTRI-031)
FORT RILEY, KANSAS

Prepared for:

U.S. Army Corps of Engineers
Kansas City District

Contract W912DQ-13-D-3000
Task Order 0004

Prepared by:

HydroGeoLogic, Inc.
6340 Glenwood, Suite 200
Building #7
Overland Park, KS 66202

October 2016

DRAFT
JULY 2016 LONG-TERM MONITORING REPORT
354 AREA SOLVENT DETECTIONS OU 005
(FTRI-031)
FORT RILEY, KANSAS

Prepared for:

U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, MO 64106

Contract W912DQ-13-D-3000
Task Order 0004

Prepared by:

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October 2016

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APPENDICES

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LIST OF ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	chemical of concern
CTI	CTI & Associates, Inc.
cy	cubic yards
DO	dissolved oxygen
DPW	Directorate of Public Works
EPA	U.S. Environmental Protection Agency
ft	feet/foot
HGL	HydroGeoLogic, Inc.
IC	institutional control
KDHE	Kansas Department of Health and Environment
LTM	long-term monitoring
LTO	long-term operations
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/L	milligrams per liter
MNA	monitored natural attenuation
mV	millivolt
ORP	oxidation-reduction potential
OU	operable unit
PCE	tetrachloroethene
QCSR	Quality Control Summary Report
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RSKs	Risk-Based Standards for Kansas
swl	static water level
TCE	trichloroethene
TCL	target compound list
TO	task order

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TOC	total organic carbon
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound

DRAFT
JULY 2016 LONG-TERM MONITORING REPORT
354 AREA SOLVENT DETECTIONS OU 005
(FTRI-031)
FORT RILEY, KANSAS

1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) is conducting long-term monitoring (LTM) at the 354 Area Solvent Detections Operable Unit (OU) 005, also referred to as site FTRI-031, at Fort Riley, Kansas (Figure 1.1). This work is being conducted under U.S. Army Corps of Engineers, Northwestern Division, Kansas City District (USACE) contract W912DQ-13-D-3000, task order (TO) 0004, regional long-term operations (LTO)/LTM. LTM sampling and reporting is being completed as required under the 2006 Record of Decision (ROD) (USACE, 2006).

This LTM Report presents the results of the July 2016 sampling event conducted by HGL, which included the following activities:

- Locate and inspect the condition of the four LTM wells and record any deficiencies found;
- Record static water level (swl) measurements for the four LTM wells;
- Collect groundwater samples from the four LTM wells. During sampling, measure and record field water quality parameters (temperature, pH, specific conductivity, oxygen reduction potential [ORP], dissolved oxygen [DO], and turbidity) to ensure field parameters had stabilized before samples are collected;
- Submit groundwater samples for analysis of volatile organic compounds (VOCs) and natural attenuation parameters (methane, ethene, ethane, alkalinity, total organic carbon [TOC], nitrate, nitrite, sulfate, sulfide, chloride), along with quality control (QC) samples (field duplicate, matrix spike/matrix spike duplicate, and trip blank);
- Validate laboratory data and report the results of data validation in a Quality Control Summary Report (QCSR); and
- Prepare this 2016 LTM Report to summarize and evaluate the laboratory analytical and hydrogeologic data from the groundwater sampling event.

The QCSR for the July 2016 sampling event was submitted as a separate report (HGL, 2016). The text and tables from the QCSR are included in Appendix A for completeness. The QCSR discusses laboratory and field quality control, including field completeness, sampling techniques, sampling precision, trip blank results, and any deviations from planned activities. The QCSR includes the validated laboratory data sheets.

1.1 SITE DESCRIPTION AND HISTORY

The following site description and history was summarized from the ROD (USACE, 2006). The former Building 354 was located at the Main Post cantonment area of the Fort Riley Military Installation, which is located in Geary and Riley Counties, near Junction City (Figure 1.1). Main Post is in the southern region of Fort Riley, north of the Kansas River. FTRI-031, which includes the former Building 354 site, currently encompasses portions of the Main Post as far north as Godfrey Avenue, and virtually the entire point bar south of the Union Pacific Railroad (UPRR) tracks and east of the Henry Drive Bridge. The point bar is part of the Kansas River floodplain and consists of approximately 60 feet (ft) of alluvial sediments overlying shale or limestone bedrock. The point bar and an ancient alluvial terrace, located to the north of the UPRR tracks, dominate the topography across FTRI-031. The terrace also consists of alluvial sediments deposited on shale and limestone bedrock; however, this area is topographically higher than the floodplain and the unconsolidated terrace deposits vary in thickness from 9 to 64 ft.

Main Post was the first part of the installation developed in the mid-nineteenth century. The post, prior to World War I, evolved from a frontier outpost to a military training post. During World War I, Fort Riley underwent significant expansion in support of the war effort. Much of this expansion took place at locations in the Kansas River alluvial valley. The Army airfield became operational in 1921. Greatly expanded, industrial infrastructure was put in place to support Army forces training for World War II. Following World War II, shops for maintaining tactical equipment were moved to Custer Hill. Today, that portion of FTRI-031 located within Main Post, to the north and west of the UPRR right-of-way, is used for vehicle maintenance and storage, office blocks, warehouses, barracks, and some residential housing units. Much of this area is covered with either concrete or asphalt, and has a high density of buried utilities, including water, sewer, electricity, gas, telephone, and fiber-optic cable. Much of the area to the south and east of the UPRR tracks, which is located on the Kansas River floodplain, is in a natural or semi-natural state, with large tracts of deciduous forest. Much of the forest area along the Kansas River is conserved as critical habitat for a transient population of bald eagles. There are some structures in this area, mainly along the UPRR tracks, which are used for warehouses and as administrative offices. Underground utilities are present, but not as dense as in the Main Post area.

The former Building 354 was constructed in 1935 as a gasoline service station with four underground storage tanks (USTs), which were used for storage of gasoline and diesel fuel. Two additional USTs were installed at the service station in 1980 and were used for diesel storage. Reports indicate that the USTs at the service station were also used to store road oil, and may have been used to store solvents. Five of the six USTs were removed in 1990 and 1991. The sixth tank, an 8,500-gallon steel UST, reportedly used for diesel storage, was not found.

FRTI-031 also includes Buildings 367 and 430. Building 367 is located on Carr Avenue and was constructed in 1903. The building originally served as an artillery gun shed and is now used for storage. Building 430 is located on Godfrey Avenue and was constructed in 1932. The building was originally built and is still maintained as a fire station. Both of these structures are on the National Register of Historic Places within the Main Post Historic District.

Following the removal of the USTs at the former Building 354 site, investigation of soil and groundwater revealed the presence of chlorinated solvent contamination. As a result, the 354 Area Solvent Detections site was formally designated OU 005 in January 1997. Specific areas identified as possible source areas included the following:

- Building 367 and adjacent paved areas.
- Building 332, former Building 354, its associated USTs, and adjacent areas of the Directorate of Public Works (DPW) Compound.
- Building 430.
- Former service station to northwest of UPRR depot.
- Petroleum unloading facility and pipeline along the UPRR tracks.

A number of field investigations were conducted at FTRI-031 and based on the results the primary chlorinated solvent source was located immediately east of Building 367. This source was principally tetrachloroethene (PCE), based on both soil and groundwater data.

In 1998, the Army began a Remedial Investigation/Feasibility Study (RI/FS) to identify the types, quantities, and locations of the contaminants at OU 005 and to develop a plan to address the contamination problem. The RI report provided the basis for the FS report, which presented the alternatives available to address potential risks identified in the RI report. The U.S. Environmental Protection Agency (EPA) and Kansas Department of Health and Environment (KDHE) approved the RI and FS reports in 2003 and 2005, respectively. A pilot study for soil remediation was performed at the Building 367 location during 2004. This remediation effort was successful in treating and removing approximately 1,000 cubic yards (cy) of soil that were contaminated with chlorinated solvents. The monitoring wells associated with OU 005 have been sampled as part of the groundwater monitoring program at Fort Riley.

1.2 PURPOSE AND SCOPE

This LTM Report presents the results of the sampling event conducted at FTRI-031 by HGL on July 11, 2016. The purpose of the July 2016 sampling was to continue groundwater monitoring at FTRI-031 in fulfillment of the ROD and to support the Five-Year Review. The selected remedy for remediation of the groundwater contamination at FTRI-031 was monitored natural attenuation (MNA) with institutional controls (ICs). MNA relies on natural degradation processes occurring at the site to further reduce contaminant concentrations to levels below the EPA maximum contaminant level (MCL), which is the cleanup goal specified in the ROD.

During the sampling event the wells were gauged, field parameters were recorded, and groundwater samples were collected using dedicated bladder pumps deployed in the wells. Sampling was conducted in accordance with the *Site-Specific Work Plan* (HGL, 2014). Fieldwork also included inspection of the monitoring wells and maintenance as needed.

This LTM Report also presents Mann-Kendall statistical analysis performed using historical data along with data collected in July 2016. Statistical analysis was performed to determine contaminant trends for site contaminants of concern (COCs), excluding *cis*-1,2-dichloroethene (*cis*-1,2-DCE), which has not been detected in the monitoring wells above the MCL. The following is a list of the COCs, as presented in the ROD, along with their respective cleanup goal, which is the MCL:

- PCE, 5 micrograms per liter (μg/L)
- trichloroethene (TCE), 5μg/L
- *cis*-1,2-DCE, 70 μg/L
- Benzene, 5μg/L

The number of sampling events at FTRI-031 are summarized in the table below.

Year	No. of Events	Year	No. of Events	Year	No. of Events
2000	3	2006	1	2012	1
2001	2	2007	1	2013	0
2002	3	2008	1	2014	2
2003	2	2009	1	2015	0
2004	2	2010	0	2016	1
2005	1	2011	1		

1.3 WELLS SAMPLED AND PARAMETERS ANALYZED

Water levels were measured at the four LTM monitoring wells prior to beginning the sampling activities. Groundwater samples were collected from the four LTM monitoring wells: 354-01-27, 354-99-09, TSO292-01, and TSO292-02. Figure 1.2 shows the location of the LTM monitoring wells.

Monitoring wells were sampled for analysis of target compound list (TCL) VOCs; and the MNA parameters methane, ethene, ethane, alkalinity, TOC, nitrate, nitrite, sulfate, sulfide, and chloride. In addition, field measurements of water quality parameters were recorded during well purging to verify the stabilization of groundwater parameters. The stabilization of groundwater parameters (temperature, pH, conductivity, and turbidity) was used to confirm that formation water was being collected prior to sampling for laboratory analysis. Natural attenuation parameters (ORP and DO) were also measured and recorded. Well purging was performed in accordance with the *Revised Standard Operating Procedure for Low-flow Groundwater Purging and Sampling* (USACE, 2002) and the *Site-Specific Work Plan, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations* (HGL, 2014).

Field samples were shipped to Accutest Laboratories, Inc. in Orlando, Florida for analysis. The results of the laboratory analyses are discussed in Section 3.2 of this report.

2.0 HYDROGEOLOGIC CONDITIONS

A majority of Fort Riley is located along the north side of the Kansas River and bordered by other bodies of water associated with the Kansas River system including Milford Lake (a reservoir on the Republican River) 2 miles to the west of Fort Riley; the Republican River (downstream of Milford Lake) to the southwest; and the Smoky Hill River approaching the border of Fort Riley from the south. Generally, three hydrogeologic environments are present beneath Fort Riley. The Kansas River alluvial sediments consist of alternating layers of sand, gravel, silt, and clay. The upland terrace areas consist of thin, unconsolidated sediments overlying bedrock. The transition zones along the river valley margins consist of colluvial deposits derived from the upland terraces overlying and intermingled with alluvial sediments of the river valley. These unconsolidated materials are underlain by alternating beds of limestone and shale (USACE, 2006).

A point bar of the Kansas River and an ancient alluvial terrace area dominate the topography across the FTRI-031 site. The point bar lies between the UPRR tracks and the Kansas River (Figure 2.1). It is an area of low relief, with ground elevations generally between 1,048 and 1,063 ft above mean sea level (amsl). The area to the north of the UPRR tracks is an ancient alluvial terrace. The topography on the terrace generally rises to the north. Elevations vary from about 1,065 ft amsl south along the railroad tracks, to approximately 1,125 ft amsl at the north portion of the study area in the vicinity of Godfrey Avenue. With the exception of the Kansas River, no perennial creeks or streams are found in the study area (USACE, 2006).

Limited groundwater is present within the terrace aquifer and larger volumes of groundwater are present in the Kansas River alluvial aquifer. Groundwater within the terrace aquifer is present directly above the bedrock surface (this is where the four LTM wells are screened), with a saturated thickness ranging from zero (dry) to about 16 ft. Groundwater flow is controlled by the topography of the bedrock surface, which imparts a southerly direction of groundwater flow. The saturated thickness within the Kansas River alluvial aquifer is greater than the terrace aquifer. Groundwater flow here is controlled in large part by the Kansas River and is to the east/southeast, across the point bar. Transmissivity is greater in the Kansas River alluvial aquifer since the saturated thickness is greater. Groundwater gradients are an order of magnitude greater within the terrace aquifer than within the Kansas River alluvial aquifer (USACE, 2006).

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3.0 SUMMARY OF RESULTS

This section summarizes the fieldwork conducted, analytical results of groundwater samples and comparison to risk-based levels, and the statistical analysis and results.

3.1 STATIC WATER LEVELS

The swls were measured in the four specified wells on July 11, 2016. Table 3.1 presents swl data collected. Figure 2.1 presents the potentiometric surface measured during July 2016. The general groundwater flow direction across FTRI-031 is to the south, toward the Kansas River. The groundwater elevations show very little variability from the previous swls collected in 2014.

3.2 WATER QUALITY PARAMETERS

Field measurements of water quality parameters were recorded during well purging to verify the stabilization of groundwater parameters. Table 3.2 presents the field parameters for the 2016 groundwater sampling event. These data were recorded on the field sampling forms, which are included in Appendix B.

3.3 WELL MAINTENANCE

The wells were inspected during each sampling event and found to be in good condition. Therefore, no maintenance was required over the reporting period.

3.4 ANALYTICAL RESULTS

Results of the laboratory analyses and historical trends in the data are discussed below. Table 3.3 presents the analytical data for the July 2016 sampling event. Alkalinity, sulfate, chloride, nitrate, and nitrite (analytical methods SM2320 B-11 and EPA 300/SW846 9056A) were not analyzed. The cooler containing the sample bottles for these analyses was lost during shipment. When the cooler containing the samples arrived at the laboratory's Service Center in Raleigh, North Carolina (not the shipping location) on July 15, 2016, the samples were above temperature and out of hold time, so the samples were discarded. Table 3.4 summarizes the 2016 VOCs detected compared to EPA MCLs (EPA, 2016) and KDHE Risk-Based Standards for Kansas (RSKs) for residential groundwater (KDHE, 2010). Table 3.4 also summarizes the results for the available MNA parameters: methane, ethane, ethene, sulfide, and total organic carbon. The chemical analyses were performed in accordance with the procedures listed in Table 1.1.

3.4.1 COC Sampling Results

During the July 2016 sampling event, all four COCs (benzene, *cis*-1,2-DCE, TCE, and PCE) were detected. Table 3.4 presents the detections compared to risk-based criteria. PCE was the only COC reported above a risk-based level. PCE was reported in wells 354-01-27, 354-99-09, and TSO292-01 at levels above the MCL of 5 μg/L.

3.4.2 Non-COC VOC Sampling Results

Analytical results from the July 2016 sampling event reported detections of non-COC VOCs. All concentrations were less than their respective MCL and KDHE RSK. Non-COC VOCs detected in 2016 and their associated screening levels are presented in Table 3.4.

3.4.3 Natural Attenuation Parameter Results

The following parameters were analyzed to help evaluate the conditions present for natural attenuation:

- methane
- ethene
- ethane
- TOC
- sulfide

The results of the 2016 sampling for the MNA parameters are presented in Table 3.3 and the results for parameters with detections are summarized in Table 3.4. MNA parameter results are further discussed in Section 3.7.

3.5 STATISTICAL ANALYSIS

The COCs for each well that were evaluated using the Mann-Kendall trend analysis are listed in Table 3.6. Data from 2000 to 2016 was used for the trend analysis. Historical data presented in Table 3.6 was obtained from Table 3-3 of the *Final Groundwater Sampling Report, April 2012* (CTI, 2012). The results of the statistical analyses are summarized below. Plots of the statistical analyses for VOCs are included in Appendix C.

3.5.1 Approach

The Mann-Kendall trend analysis was conducted to identify trends in COC concentrations at FTRI-031. Before running the trend analysis on the data presented in Table 3.6, "U" coded data (data where there was no detection above the method detection limit) were converted to values representing half the presented detection limit. HGL developed Table 3.6 by combining historical data with current data. For historical data not collected by HGL, an assumption is made that COCs are not presented in Table 3.6 if they have not historically been detected.

3.5.2 Results of Statistical Analysis

The results of the Mann-Kendall trend analyses are summarized below:

COC	354-01-27	354-99-09	TSO292-01	TSO292-02
Benzene	NA	NA	No Trend	Decreasing
cis-1,2-DCE	Not detected above the maximum contaminant level			
PCE	Decreasing	Decreasing	Probably Decreasing	NA
TCE	Decreasing	Decreasing	No Trend	NA

Note: NA = Mann-Kendall trend not analyzed; insufficient number of detections to perform analysis.

Overall, concentrations show decreasing trends for benzene, PCE, and TCE, except in well TSO292-01 where benzene and TCE currently are showing no trend in the data.

3.6 2016 DISTRIBUTION OF COCs IN GROUNDWATER

As presented on Table 3.4, PCE has been detected in wells 354-01-27, 354-99-09, and TSO292-01 at concentrations above the MCL. However, down-gradient well TSO292-02 had no detections of PCE during 2016. TCE was detected only in well TSO292-01 at a level below the MCL and was not detected in down-gradient well TSO292-02. Benzene was detected in wells TSO292-01 and TSO292-02, and *cis*-1,2-DCE was detected only in TSO292-01, but detections were below the MCL. The four monitoring wells are all screened at comparable elevations (see Table 3.1).

3.7 NATURAL ATTENUATION PARAMETERS

The MNA parameters methane, ethane, ethene, TOC, and sulfide, were analyzed in the laboratory. Temperature, pH, DO, and ORP readings were monitored as part of the well purging stabilization process.

Data were compared to the Analytical Parameters and Weighting for Preliminary Screening for Anaerobic Biodegradation Processes table in the *Technical Protocol for the Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998) (Table 3.5). The following results are considered to be favorable for reductive dechlorination:

- pH was reported between 5.0 and 9.0 in all samples.
- Temperature was recorded above 20°C in wells 354-01-27 and TSO292-02.
- ORP was reported below 50 millivolts (mV) in all samples.
- DO was recorded below 0.5 milligrams per liter (mg/L) in well TSO292-02.

The wells with favorable MNA parameters are the most up-gradient well (354-01-27), and the down-gradient well (TSO292-02).

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4.0 SUMMARY AND RECOMMENDATIONS

This section summarizes the groundwater flow direction derived from water level measurements, analytical results, and statistical analysis results for the July 2016 groundwater sampling events at the FTRI-031.

4.1 GROUNDWATER FLOW

During the July 2016 groundwater sampling events, measured water levels indicate that the groundwater flow direction at FTRI-031 was generally to the south, toward the Kansas River. The groundwater elevations showed little variability from the 2014 sampling events.

4.2 ANALYTICAL RESULTS

4.2.1 COCs

The COCs, as presented in the ROD, are listed below along with their respective MCL:

- PCE, 5µg/L
- TCE, 5µg/L
- *cis*-1,2-DCE, 70 µg/L
- Benzene, 5µg/L

During the 2016 sampling event PCE results from 354-01-27, 354-99-09, and TSO292-01 were the only COC detections above MCLs. The maximum concentration detected was at well TSO292-01 at 45.1 µg/L. PCE was not detected in the down-gradient well TSO292-02. See Table 3.4 for elevated PCE values.

4.2.2 Non-COC VOCs

During the 2016 sampling event all concentrations of non-COC VOCs were less than their respective MCLs and KDHE RSKs.

4.3 RECOMMENDATIONS

HGL recommends that future groundwater sample analysis include only the four COCs:

- PCE
- TCE
- *cis*-1,2-DCE
- Benzene

along with the current list of MNA parameters:

- methane
- ethene
- ethane
- TOC
- sulfide

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5.0 REFERENCES

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TABLES

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Table 1.1
Analytical Method Requirements
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Analytical Group	Method	Sample Containers	Holding Time	Preservation
Dissolved Gases	RSK 175	(3) 45-mL VOA vials	14 days	Cool 4°C, pH <2 with HCl
TOC	SM5310 B-11/ SW9060A	(2) 45-mL VOA vials, amber	28 days	Cool 4°C, pH <2 with HCl
Alkalinity	SM2320 B-11	(1) 1000 mL nalgene	14 days	Cool 4°C
Nitrate/Nitrite	EPA 300/ SW846 9056A	(1) 1000 mL nalgene	48 hours	Cool 4°C
Sulfate, Chloride	EPA 300/ SW846 9056A	(1) 1000 mL nalgene	28 days	Cool 4°C
Sulfide	SM4500-S^{2-}-F11	(3) 250 mL nalgene	7 days	Cool 4°C, pH>10 NaOH
VOC	SW846 8260B	(3) 45-mL VOA vials	14 days	Cool 4 °C, HCl to pH <2

Notes:
< = less than
> = greater than
°C = degrees Celsius
HCL = hydrochloric acid
mL = milliliters
NaOH = sodium hydroxide
TOC = total organic carbon
VOA = volatile organic analysis
VOC = volatile organic compound

Table 3.1
Static Water Levels
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well ID	Top of Casing Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Total Well Depth (ft bgs)	Screened Interval		March 18, 2014		July 16, 2014		July 11, 2016	
				(ft bgs)	(ft amsl)	Depth to Water (ft btoc)	Static Water Level Elevation (ft amsl)	Depth to Water (ft btoc)	Static Water Level Elevation (ft amsl)	Depth to Water (ft btoc)	Static Water Level Elevation (ft amsl)
354-01-27	1116.38	1113.6	57.3	47.0 - 56.7	1066.6 - 1056.9	51.90	1064.48	51.90	1064.48	51.11	1065.27
354-99-09	1091.12	1088.7	34.6	22.1 - 33.1	1066.6 - 1055.6	31.64	1059.48	*	-	*	-
TS0292-01	1084.00	1083.5[a]	29.9	19.8 - 29.8	1063.7 - 1053.7	24.76	1059.24	24.55	1059.45	24.34	1059.66
TS0292-02	1066.02	1065.7[a]	17.4	7.0 - 17.0	1058.7 - 1048.7	13.9	1052.12	13.66	1052.36	13.40	1052.62

Notes:

All wells are 2 inches in diameter.

Elevation, depth and screen interval information is from the *Remedial Design/Remedial Action Plan* (Malcolm Pirnie and Burns & McDonnell, 2007), except "a" noted data which were calculated based on data presented in the Groundwater Sampling Report (CTI, 2012).

* = water level below top of pump

- = measurement unknown

bgs = below ground surface

ft = feet

ft amsl = feet above mean sea level

ft btoc = feet below top of casing

ID = identification

NA = not available

Table 3.2
Field Monitoring Parameters
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well ID	Date Sampled	Sampling Time	Approximate Amount Purged (Liters)	Flow Rate (mL/min)	Temperature (°C)	pH	Conductivity (µS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Water Level (ft btoc)
354-01-27	7/11/2016	1605	4.4	125	20.89	6.74	680	7.41	1.0	5.79	51.49
354-99-09	7/11/2016	1510	3.8	125	19.26	6.73	1625	4.20	2.0	6.54	*
TS0292-01	7/11/2016	1250	5.6	125	19.44	6.64	1440	6.98	-13.5	0.99	24.63
TS0292-02	7/11/2016	1400	3.8	125	20.20	6.82	717	10.6	-58.3	0.44	14.10

Notes:

* = water level below top of pump

°C = degrees Celsius

DO = dissolved oxygen

Fe^{+2} = ferrous iron

ft btoc = feet below top of casing

ID = identification

µS/cm = microsiemens per centimeter

mg/L = milligrams per liter

mL/min = milliliters per minute

mV = millivolts

NTU = nephelometric turbidity units

ORP = oxygen reduction potential

Table 3.3
Laboratory Analytical Data
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**TSO292-01**		**TSO292-02**	**354-01-27**	**354-99-09**
Sample ID	**FTRI031-TS0292-01-072016**	**DUP01-07/11/16**	**FTRI031-TS0292-02-072016**	**FTRI031-354-01-27-072016**	**FTRI031-354-99-09-072016**
Sample Date	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**
Volatile Organic Compounds (μg/L)					
Acetone	20 U	20 U	20 U	20 U	20 U
Benzene	**0.29 J**	**0.37 J**	**0.62 J**	0.50 U	0.50 U
Bromobenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	0.50 U	0.50 U	0.50 UJ	0.50 U	0.50 U
2-Butanone (MEK)	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U
n-Butylbenzene	0.50 U	0.50 U	**0.68 J**	0.50 U	0.50 U
sec-Butylbenzene	0.50 U	0.50 U	**10.7**	0.50 U	0.50 U
tert-Butylbenzene	0.50 U	0.50 U	**3.6**	0.50 U	0.50 U
Carbon Disulfide	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U
Carbon Tetrachloride	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	**0.65 J**	**0.58 J**	0.50 U	0.50 U	**0.31 J**
o-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
p-Chlorotoluene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dibromo-3-chloropropane	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromoethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dichlorodifluoromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethylene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethylene	**0.84 J**	**0.78 J**	0.50 U	0.50 U	0.50 U
trans-1,2-Dichloroethylene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2,2-Dichloropropane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	0.50 U	0.50 U	0.50 UJ	0.50 U	0.50 U
trans-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	0.50 U	**0.27 J**	0.50 U	0.50 U	0.50 U
2-Hexanone	5 U	0.50 U	0.50 U	0.50 U	0.50 U
Isopropylbenzene	0.50 U	0.50 U	**3.0**	0.50 U	0.50 U
p-Isopropyltoluene	0.50 U	0.50 U	**0.30 J**	0.50 U	0.50 U
Methyl Bromide	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Chloride	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methylene Bromide	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methylene Chloride	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
4-Methyl-2-pentanone (MIBK)	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Methyl Tert Butyl Ether	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Naphthalene	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
n-Propylbenzene	0.50 U	0.50 U	**0.54 J**	0.50 U	0.50 U
Styrene	0.50 U	0.50 U	0.50 UJ	0.50 U	0.50 U
1,1,1,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethylene	**45.1**	**44.9**	0.50 U	**13.7**	**13.1**
Toluene	0.50 U	0.50 U	**0.21 J**	0.50 U	0.50 U

Table 3.3
Laboratory Analytical Data
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**TSO292-01**		**TSO292-02**	**354-01-27**	**354-99-09**
Sample ID	**FTRI031-TS0292-01-072016**	**DUP01-07/11/16**	**FTRI031-TS0292-02-072016**	**FTRI031-354-01-27-072016**	**FTRI031-354-99-09-072016**
Sample Date	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**
Volatile Organic Compounds (µg/L)					
1,2,3-Trichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1,1-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethylene	**3.2**	**3.1**	0.50 U	0.50 U	0.50 U
Trichlorofluoromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,3-Trichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3,5-Trimethylbenzene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m,p-Xylene	1.0 U	1.0 U	**1.0 J**	1.0 U	1.0 U
o-Xylene	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Natural Attenuation Parameters					
Methane (µg/L)	**2.8**	**3.1**	**21.3**	0.25 U	0.25 U
Ethane (µg/L)	0.50 U	0.50 U	**0.33 J**	0.50 U	0.50 U
Ethene (µg/L)	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Sulfide (mg/L)	**0.22 J**	**0.26 J**	**0.64 J**	**0.61 J**	**0.72**
Total Organic Carbon (mg/L)	**1.8 J**	**1.9 J**	**3.0 J**	**1.0 J**	**0.96 J**
Alkalinity (mg/L)	NA	NA	NA	NA	NA
Chloride (mg/L)	NA	NA	NA	NA	NA
Nitrogen, Nitrite (mg/L)	NA	NA	NA	NA	NA
Nitrogen, Nitrate (mg/L)	NA	NA	NA	NA	NA
Sulfate (mg/L)	NA	NA	NA	NA	NA

Notes:

Shading = detections above the MCL (see Table 3.4)

BOLD = dectected concentration

HQ = hazard quotients

ID = identification

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

µg/L = micrograms per liter

mg/L = milligrams per liter

NA = not analyzed

TR = target cancer risk

U = Not detected. The associated number indicates the analyte limit of detection.

UJ = Not detected. The associated number indicates the analyte limit of detection, which may be inaccurate.

Table 3.4
Summary of VOC and Natural Attenuation Parameter Detections
July 2016 Groundwater Sampling Event
OU 005, FTR-031, Fort Riley, Kansas

Well ID			**354-01-27**	**354-99-09**	**TSO292-01**		**TSO292-02**
Field Sample ID			**FTRI031-354-01-27 -072016**	**FTRI031-354-99-09 -072016**	**FTRI031-TSO292-01 -072016**	**DUP01 -07/11/16**	**FTRI031-TSO292-02 -072016**
Sample Date	**MCL[1]**	**RSK[2]**	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**
COC Volatile Organic Compounds (μg/L)							
Benzene	**5**	5	0.50 U	0.50 U	**0.29 J**	**0.37 J**	**0.62 J**
cis-1,2-Dichloroethene	**70**	70	0.50 U	0.50 U	**0.84 J**	**0.78 J**	0.50 U
Tetrachloroethene	**5**	5	**13.7**	**13.1**	**45.1**	**44.9**	0.50 U
Trichloroethene	**5**	5	0.50 U	0.50 U	**3.2**	**3.1**	0.50 U
Non-COC Volatile Organic Compounds (μg/L)[3]							
Chloroform	**80**	80	0.50 U	**0.31 J**	**0.65 J**	**0.58 J**	0.50 U
Ethylbenzene	**700**	700	0.50 U	0.50 U	0.50 U	**0.27 J**	0.50 U
Isopropylbenzene (Cumene)	450	451	0.50 U	0.50 U	0.50 U	0.50 U	**3.0**
m,p-Xylene	**10000**	10000	1.0 U	1.0 U	1.0 U	1.0 U	**1.0 J**
n-Butylbenzene	1000	169	0.50 U	0.50 U	0.50 U	0.50 U	**0.68 J**
n-Propylbenzene	**660**	660	0.50 U	0.50 U	0.50 U	0.50 U	**0.54 J**
p-Isopropyltoluene	-	-	0.50 U	0.50 U	0.50 U	0.50 U	**0.30 J**
sec-Butylbenzene	2000	305	0.50 U	0.50 U	0.50 U	0.50 U	**10.7**
tert-Butylbenzene	690	-	0.50 U	0.50 U	0.50 U	0.50 U	**3.6**
Toluene	**1000**	1000	0.50 U	0.50 U	0.50 U	0.50 U	**0.21 J**
Natural Attenuation Parameters[3]							
Ethane (μg/L)	-	-	0.50 U	0.50 U	0.50 U	0.50 U	**0.33 J**
Methane (μg/L)	-	-	0.25 U	0.25 U	**2.8**	**3.1**	**21.3**
Sulfide (mg/L)	-	-	**0.61 J**	**0.72**	**0.22 J**	**0.26 J**	**0.64 J**
Total organic carbon (mg/L)	-	-	**1.0**	**0.96 J**	**1.8**	**1.9**	**3.0**

Notes:

[1] MCL (BOLD) or Tap Water Screening Level if no MCL. Values from EPA Regional Screening Levels Summary Table (TR=1E-6, HQ=1) May 2016.

[2] Groundwater, Residential Scenario, Risk-Based Standards for Kansas RSK Manual – 5th Version, October 2010 with revised tables from September 2015.

[3] Compounds for which there is at least one reported detection in an environmental sample.

Bold = detected concentrations

Shading = above MCL or RSK

\- = No MCL or Tapwater Screening Level

ID = identification

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

μg/L = micrograms per liter

MCL = maximum contaminant level

mg/L = milligrams per liter

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.5
Groundwater MNA Parameters
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**Favorable Geochemical Conditions***	**354-01-27**	**354-99-09**	**TS0292-01**	**TS0292-02**
Sample Date		**7/11/2016**	**7/11/2016**	**7/11/2016**	**7/11/2016**
Temperature (°C)	>20	**20.89**	19.26	19.44	**20.2**
pH	>5 <9	**6.74**	**6.73**	**6.64**	**6.82**
Dissolved Oxygen (mg/L)	<0.5	5.79	6.54	0.99	**0.44**
Oxygen Reduction Potential (mV)	<50	**1.0**	**2.0**	**-13.5**	**-58.3**
Alkalinity (mg/L)	>2x Background	NA	NA	NA	NA
Methane (μg/L)	>500	0.25 U	0.25 U	**3.1**	**21.3**
Ethane (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.33 J
Ethene (μg/L)	>10	0.50 U	0.50 U	0.50 U	0.50 U
Chloride (mg/L)	>2x Background	NA	NA	NA	NA
Nitrate, as N (mg/L)	<1	NA	NA	NA	NA
Sulfate (mg/L)	<20	NA	NA	NA	NA
Sulfide (mg/L)	>1	**0.61 J**	**0.72**	**0.26 J**	**0.64 J**
Total Organic Carbon (mg/L)	>20	**1.0**	**0.96 J**	**1.9**	**3.0**

Notes:

* Based on *Technical Protocol for the Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998).

Bold = detection

Shading = favorable geochemical conditions for natural attenuation of contaminants.

Background well is 354-01-28, chloride 29 mg/L and alkalinity 378 mg/L measured on March 4, 2009.

< = less than

> = greater than

°C = degrees Celsius

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

mg/L = milligrams per liter

mV = millivolts

μg/L = micrograms per liter

NA = not analyzed because sample bottles lost by shipping carrier.

U = Not detected. The associated number indicates the analyte limit of detection.

Table 3.6
Historical Laboratory Analytical Results
July 2016 Groundwater Sampling Event
OU 005, FTRI-031, Fort Riley, Kansas

Well Location	**354-01-27**		**354-99-09**		**TS0292-01**			**TS0292-02**
Analyte	**PCE**	**TCE**	**PCE**	**TCE**	**PCE**	**TCE**	**Benzene**	**Benzene**
MCL	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Sample Date								
February 2000	NA	NA	**25.1**	0.6 U	**69.3**	**3.2**	**3.5**	**14.6**
July 2000	NA	NA	**96.8**	**1.4**	**75.9**	**3.3**	**3.2**	**17.5**
October 2000	NA	NA	**75.9**	**1.2**	**56.8**	**3.6**	**4.2**	**25.3**
March 2001	NA	NA	**53.2**	**1**	**66.5**	**3.6**	**0.9**	**15.2**
October 2001	**181**	**2.6**	**58.2**	**1.1**	**44.2**	**2.7**	**3**	**17.8**
January 2002	**208**	**2.8**	**50.8**	**0.8**	**27.9**	**2.2**	0.4 U	**31**
April 2002	**166**	**2.5**	**29.3**	0.6 U	**33**	**2.2**	0.4 U	**37.4**
July 2002	**179**	**3.2**	**27.5**	0.6 U	**39**	**2.7**	0.4 U	**40.3**
March 2003	**180**	**1.9**	**31.7**	**0.7**	**32.6**	**3**	0.4 U	**42.6**
September 2003	**121**	**1.7**	**27.7**	**0.7**	**21.6**	**3**	**0.7**	**18.8**
April 2004	**95.9**	**1.3**	**60**	**1.2**	**32.1**	**2.7**	0.4 U	**7.5**
October 2004	**71.7**	**1.2**	**37.8**	**0.7**	**24.8**	**3**	0.4 U	**25**
April 2005	**98.5**	**1**	**27.3**	0.6 U	**55.8**	**3.8**	0.4 U	**24**
September 2006	**96.6**	**0.9**	**75.9**	**1.1**	**23.3**	**2.8**	**9.5**	**12.3**
April 2007	**82.9**	**1.1**	**49**	**0.7**	**43**	**3.9**	0.5 U	**10**
March 2008	**76.1**	**1**	**39.4**	0.6 U	**60.4**	**5.7**	**0.5**	**7.8**
March 2009	**21.1**	**0.6 J**	**34.5**	0.6 U	**49.5**	**2.8**	0.5 U	**4.3**
August 2011	**28**	1.0 U	**13**	1.0 U	**20**	**2.1**	**0.2 J**	**7.9**
April 2012	**8.9**	1.0 U	**8.1**	1.0 U	**13**	**1.2**	1.0 U	**3.3**
March 2014	**94.1**	**1.4**	**33.1**	**0.45 J**	**56.6**	**4.3**	0.50 U	0.50 U
July 2014	**80.5**	**1.1**	**27.3**	**0.31 J**	**50.1**	**4.6**	**0.58 J**	**2.7**
July 2016	**13.7**	0.50 U	**13.1**	0.50 U	**45.1**	**3.2**	**0.37 J**	**0.62 J**

Notes:

Results are in µg/L

Bold = detection

Shading = analyte concentration exceeds MCL.

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

µg/L = micrograms per liter

NA = not analyzed

PCE = Tetrachloroethene

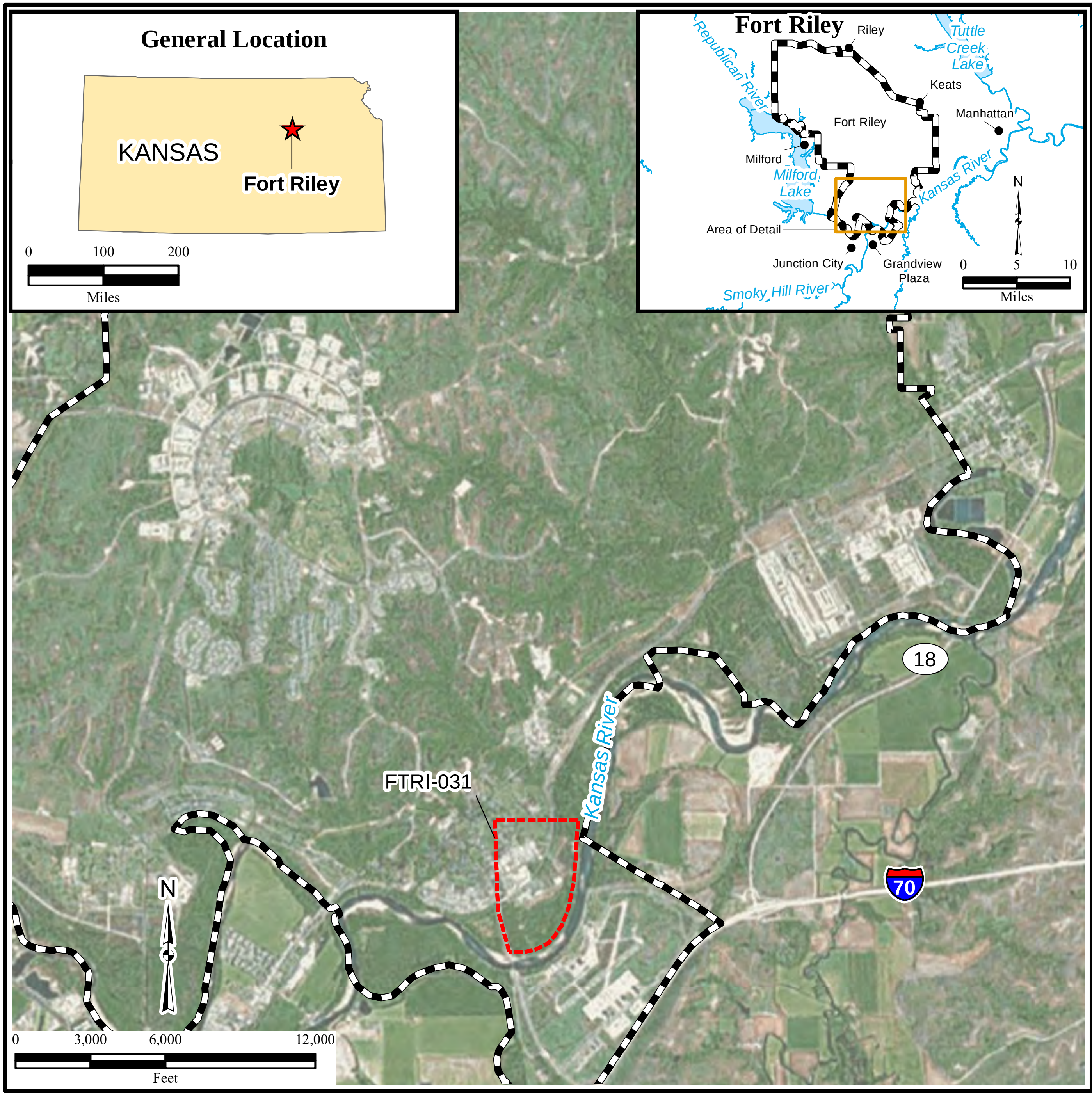
TCE = Trichloroethene

U = Not detected. The associated number indicates the analyte limit of detection.

FIGURES

HGL, July 2016 LTM Report,
FTRI-031, Fort Riley, KS, Regional LTO/LTM

Figure 1.1
Site Location



Legend

- ● City
- ▬ Fort Riley Boundary
- — Surface Water Course
- ▭ Surface Water Body
- ▭ FTRI-031 Site

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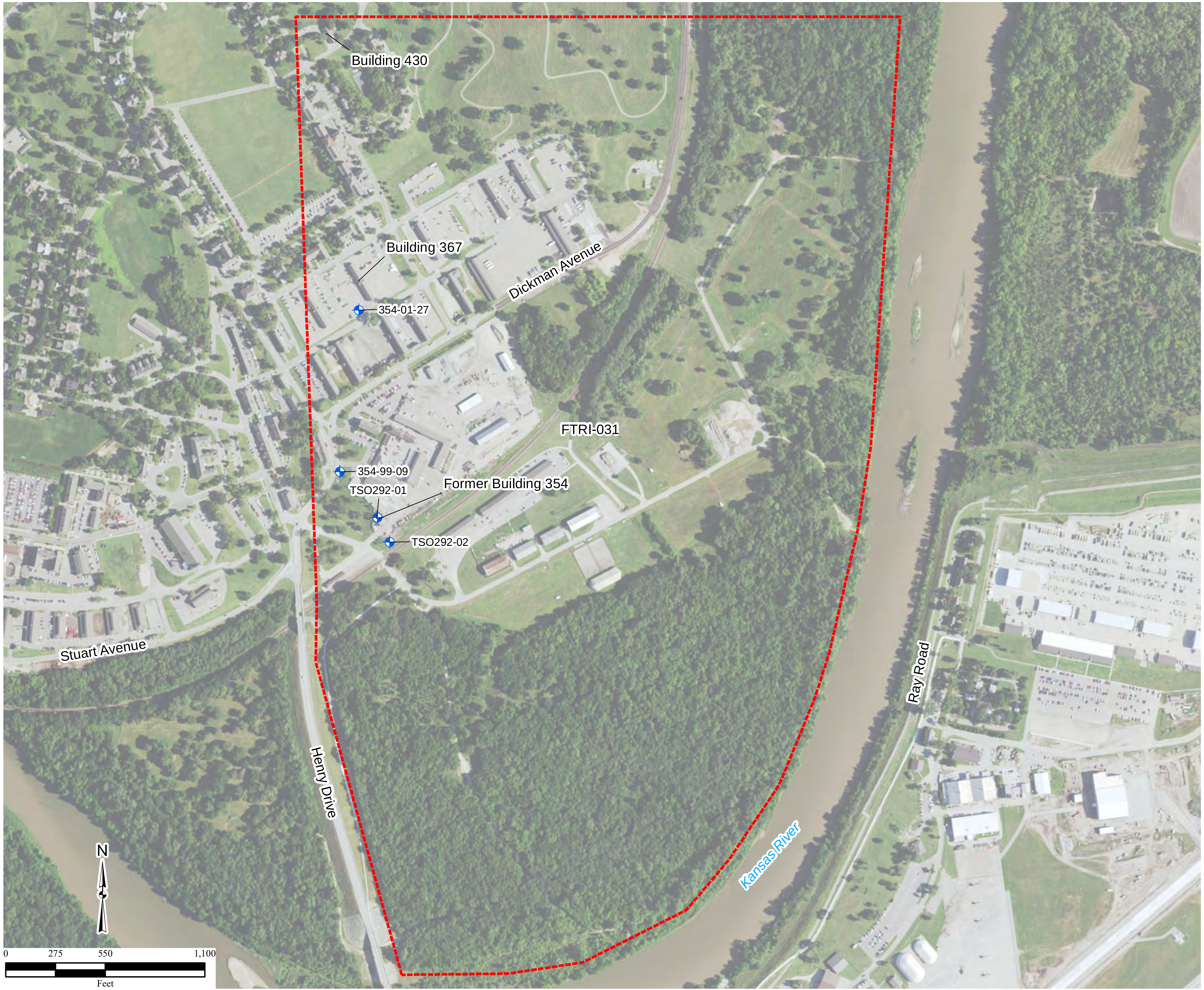
8/16/2016 JG
Source: HGL,
ArcGIS Online Imagery

HGL HydroGeoLogic, Inc

Figure 1.2
LTM Well Locations



Legend

⌖ LTM Well

▭ FTRI-031 Site

Note:
LTM=long-term monitoring

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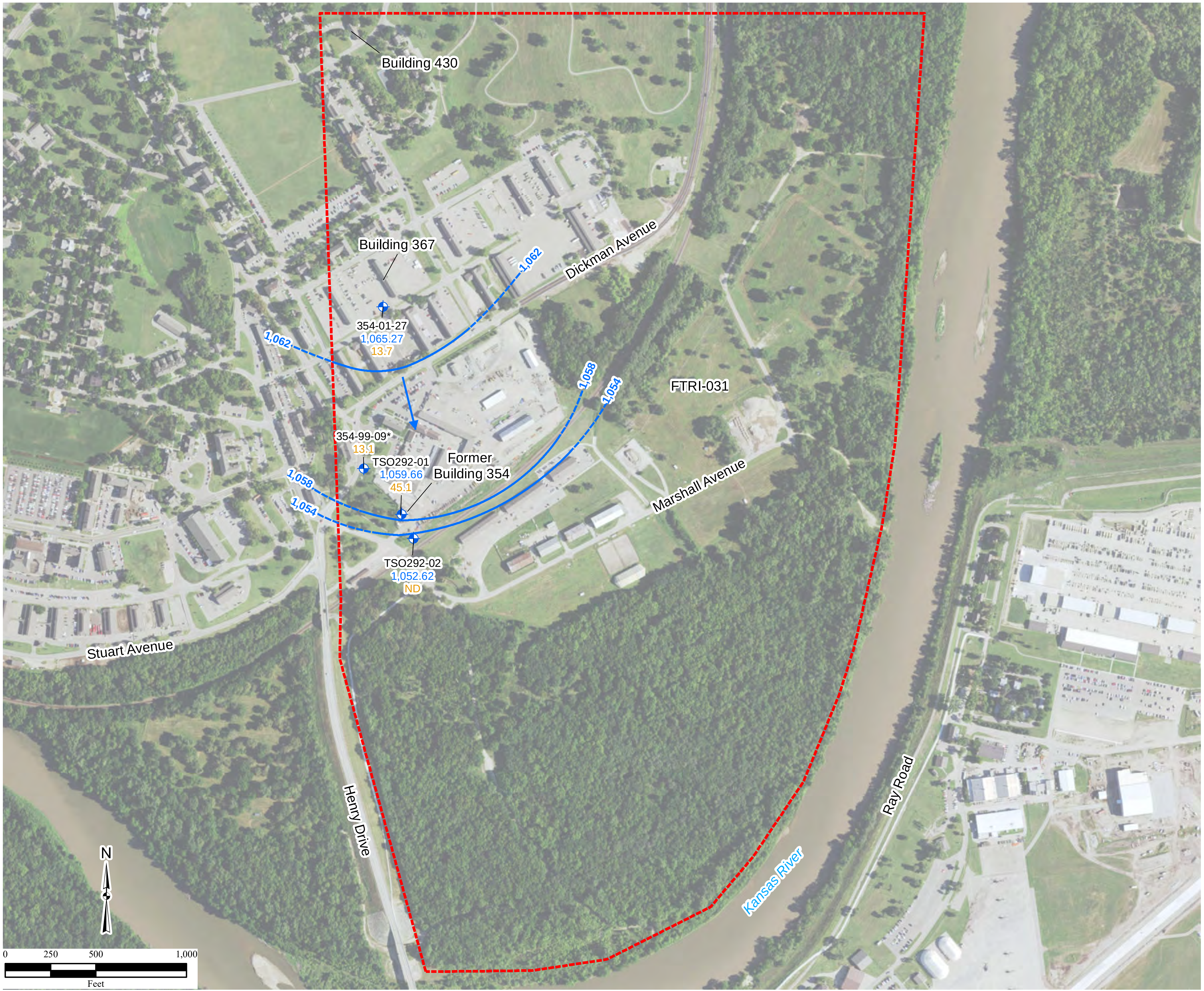
(1-02)LTM_Locations_FTRI031.mxd
9/8/2016 JG
Source: HGL,
ArcGIS Online Imagery

Figure 2.1
Potentiometric Surface and PCE Concentrations July 2016



Legend

⌖ LTM Well

TSO292-01 — Monitoring Well Identification
1,059.66 — Groundwater Elevation (ft amsl)
45.1 — PCE Concentration (µg/L)

-1,054- Groundwater Elevation Contour (ft amsl, dashed where inferred)

→ Direction of Inferred Groundwater Flow

▭ FTRI-031 Site

Notes:
*=water level below top of pump
µg/L=micrograms per liter
ft amsl=feet above mean sea level
LTM=long-term monitoring
ND=nondetect
PCE=tetrachloroethene

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9/8/2016 JG
Source: HGL, ArcGIS Online Imagery

APPENDIX A

QUALITY CONTROL SUMMARY REPORT

(TEXT AND TABLES ONLY)

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DRAFT
QUALITY CONTROL SUMMARY REPORT
JULY 2016 SAMPLING
354 AREA SOLVENT DETECTIONS OU005
(FTRI-031)
FORT RILEY, KANSAS

REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

Prepared for:

U. S. Army Corps of Engineers
Kansas City District

Contract W912DQ-13-D-3000
Task Order 0004

Prepared by:

HydroGeoLogic, Inc.
6340 Glenwood, Suite 200
Building #7
Overland Park, KS 66202

October 2016

DRAFT
QUALITY CONTROL SUMMARY REPORT
JULY 2016 SAMPLING
354 AREA SOLVENT DETECTIONS OU005
(FTRI-031)
FORT RILEY, KANSAS

REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

Prepared for:

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Kansas City District
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Kansas City, MO 64106

Contract W912DQ-13-D-3000
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October 2016

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Appendix B Data Validation Reports
Appendix C Field Forms *(Provided on CD)*

LIST OF ACRONYMS AND ABBREVIATIONS

%R	percent recovery
ADR	Automated Data Review, specifically ADR.net
CCV	continuing calibration verification
FSP	Field Sampling Plan
HGL	HydroGeoLogic, Inc.
ID	identification
IS	internal standard
J	The analyte was detected at the reported concentration; the quantitation is an estimate.
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LTM	long-term monitoring
MS	matrix spike
MSD	matrix spike duplicate
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RPD	relative percent difference
SDG	sample delivery group
SSHP	Site Safety and Health Plan
TOC	total organic carbon
U	Not detected. The associated number indicates the analyte LOD.
UJ	Not detected. The associated number indicates the analyte LOD, which may be inaccurate.
VOC	volatile organic compound

DRAFT
QUALITY CONTROL SUMMARY REPORT
JULY 2016 SAMPLING
354 AREA SOLVENT DETECTIONS OU005
(FTRI-031)
FORT RILEY, KANSAS

REGIONAL LTO/LTM FOR SEVEN INSTALLATIONS

1.0 INTRODUCTION

Long-term monitoring (LTM) sampling was completed by HydroGeoLogic, Inc. (HGL) in July 2016 at 354 Area Solvent Detections, Operable Unit 005 (FTRI-031), Fort Riley, Kansas. Sampling was conducted in accordance with the Record of Decision (USACE, 2006), the Draft Final Remedial Design/Remedial Action Plan (Malcolm Pirnie and Burns & McDonnell, 2007), and with the Field Sampling Plan (FSP) and the Revision 1 Quality Assurance Project Plan (QAPP)(HGL, 2015). The FSP and QAPP, along with the Site-Specific Site Safety and Health Plan (SSHP) Addendum make up the Site-Specific Work Plan (HGL, 2014).

This Quality Control Summary Report (QCSR) presents a summary of the chemical data quality review for the samples collected by HydroGeoLogic, Inc. (HGL) in July 2016. Groundwater samples were collected for analysis of the following:

- Volatile organic compounds (VOCs) by method SW846 8260B;
- Dissolved gasses by method RSK SOP 147/175;
- Alkalinity by method SM2320 B-11;
- Sulfate, Chloride, Nitrate, and Nitrite by method EPA 300/SW846 9056A;
- Sulfides by method SM4500S^{2-}-F-11; and
- Total organic carbons (TOC) by method SM5310 B-11/SW9060A

Accutest Laboratories, Inc. Southeast in Orlando, Florida performed all groundwater sample analyses and HSW Engineering from Tampa, Florida, conducted the data validation. Table 1 presents a list of the sample locations planned for collection as identified in the FSP. Table 2 lists the samples collected, corresponding sample identification (ID) number, date sampled, date of sample receipt by the laboratory, laboratory sample delivery group (SDG) number and the requested analyses for each sample. The analytical data packages are included as Appendix A, along with associated chain of custody records, summary forms, and raw data for all sampling events. Appendix B presents the data validation reports and Automated Data Review (ADR) exports. Appendix C presents the field forms from the July 2016 sampling event.

2.0 SAMPLING ACTIVITIES

Table 1 presents the planned groundwater sampling at site FTRI-031. Sampling was conducted in conformance with the QAPP, and sampling procedures followed the FSP. Table 2 summarizes the groundwater samples collected from July 11, 2016.
Table 2 provides the following information sorted by field sample ID:

- Field sample IDs;
- Dates of sample collection and sample receipt by the laboratory;
- Laboratory SDG numbers;
- Laboratory sample IDs; and
- Analytical method.

Field quality control (QC) samples collected during the July 2016 groundwater sampling are presented in Table 3. One field duplicate sample was collected, and one trip blank was submitted to the laboratory with the VOC sample shipment. Extra volume was collected along with one sample for matrix spike (MS)/matrix spike (MSD) analyses.

3.0 DATA QUALITY EVALUATION PROCEDURES

The following subsections present the data quality evaluation procedures performed in accordance with the QAPP. Both project-specified limits and laboratory control limits were used to assess data quality. Table 4 presents a list of data validation qualifiers that may be applied during the data validation process. Table 5 summarizes the results for samples in each sampling event for which a VOC was reported at a detectable concentration. Table 6 presents a summary of the data quality evaluation for each sampling event.

3.1 SAMPLE RECEIPT AT THE LABORATORY

The cooler containing the sample bottles for analysis by analytical methods SM2320 B-11 and EPA 300/SW846 9056A was lost during shipment. When the cooler containing the samples arrived at the laboratory's Service Center in Raleigh, North Carolina (not the shipping location) on July 15, 2016 the samples were above the required temperature range and out of hold time. The samples were discarded and were not analyzed. All other sample analyses met the custodial possession and transfer requirements, the required temperature range of 4 ± 2 °C, and other preservation requirements.

3.2 HOLDING TIMES

See Section 3.1 regarding sample bottles for analysis by analytical methods SM2320 B-11 and EPA 300/SW846 9056A. All other extractions and analyses were performed within method-specific holding times.

3.3 TUNING AND CALIBRATION

According to the QAPP, evaluation of tune and calibration information is assessed using the laboratory case-narrative or summary forms. No deviations for the calibration and tuning of pertinent instrumentation were reported by the laboratory in the case narrative for the SDGs reported from the July 2016 sampling events. Evaluation of the calibration summary forms indicated that all project criteria were met for the SDG from the July 2016 groundwater sampling event.

3.4 LABORATORY METHOD BLANKS

A laboratory method blank is an analyte-free matrix that is carried through the entire preparation and analysis sequence for the purpose of identifying potential contamination introduced during preparation and analysis. Method blanks were analyzed for each sample batch for all analyses.

In accordance with the QAPP, detections are qualified as not detected (U) if the concentration in the sample is less than 5 times the concentration in the associated blank. For common laboratory contaminants, detections are qualified U if the concentration in the sample is less than 10 times the concentration in the associated blank. Sample results that are either nondetect, or greater than 5 or 10 times the blank result do not require qualification.

There were no detections of target analytes in any of the laboratory method blanks.

3.5 TRIP BLANKS

A trip blank is an analyte-free matrix that accompanies samples through the sample collection and transportation process to identify potential VOC cross-contamination. In accordance with the QAPP, detections are qualified U if the concentration in the sample is less than 5 times the concentration in the associated blank (10 times for common laboratory contaminants). Sample results that are either nondetect, or greater than 5 or 10 times the blank result do not require qualification.

The trip blank associated with the samples was contaminated with methylene chloride and carbon disulfide, however neither compound was detected in any associated sample and no qualification was required.

3.6 EQUIPMENT BLANKS

An equipment blank is an analyte-free matrix that is poured over or through reusable sampling equipment after it has been through the decontamination process, and prior to sampling. An equipment blank is used to identify potential cross-contamination from inadequate decontamination processes. In accordance with the QAPP, detections are qualified U if the concentration in the sample is less than 5 times the concentration in the associated blank (10 times for common laboratory contaminants). Sample results that are either below the detection limit, or greater than 5 or 10 times the blank result do not require qualification.

No equipment blanks were associated with the July 2016 sampling event at site FTRI-031.

3.7 SURROGATES

Surrogates are compounds not normally found in the environment that are added (spiked) into samples prior to extraction (for extractable methods) or prior to analysis (for non-extractable methods). The percent recovery (%R) of each surrogate is used to assess the success of the sample preparation process for an individual sample. Surrogates were analyzed for each sample for VOC analysis.

In accordance with the QAPP, results for associated analytes in the affected samples are qualified J for detects and qualified UJ for nondetects if the surrogate %Rs are below the laboratory QC limits, but greater than 10%. Nondetects are rejected and qualified R if %Rs are less than 10%. Also in accordance with the QAPP, results for associated analytes in the affected samples are qualified J for detections if the %R is greater than the QC limits. No action is required for nondetects.

No surrogate issues were noted.

3.8 INTERNAL STANDARDS

Internal standards (IS) are substances that are introduced in a known amount into each calibration standard and field and QC sample. The %R of each IS is used to assess the success of the system in measuring concentrations accurately. ISs were analyzed for each sample for all analyses.

It was noted that the first eluting internal standard (tert butyl alcohol-d10) in the analysis of sample FTRI031-TSO292-01 yielded an area count that was less than the lower acceptance limit. However, this internal standard is not used to quantify any of the analytes that were detected in this sample, and the area counts were sufficiently high (as were surrogate recoveries) to conclude that the reporting of non-detections was not adversely affected. No qualification was applied. All other IS recoveries were within QC limits for all samples.

3.9 LABORATORY CONTROL SAMPLES AND LABORATORY CONTROL SAMPLE DUPLICATES

A laboratory control sample (LCS) consists of a matrix, similar to that of the field sample, which is spiked with known concentrations of analytes. The LCS %R is a measure of the accuracy of the preparation and analytical methods. The laboratory control sample duplicate (LCSD) is a duplicate preparation and analysis of the LCS. The differences between the LCS and LCSD recoveries are used to calculate the relative percent difference (RPD), which is a measure of the precision of the preparation and analytical methods. LCS samples were analyzed for each sample batch for all analyses.

In accordance with the QAPP, results for the affected analyte in the associated samples are qualified J for detects and UJ for nondetects if the LCS %R is below the laboratory QC limits, but greater than 10%. Nondetects are rejected and qualified R if the %R is less than 10%. Also in accordance with the QAPP, results for the affected analyte in the associated samples are qualified J for detects if the %R is greater than the QC limits. No action is required for nondetects. Additionally, results for the affected analyte in the associated samples are qualified J for detects and UJ for nondetects if the LCS/LCSD RPD exceeds 20%.

All %Rs and RPDs were within laboratory QC limits.

3.10 MATRIX SPIKES AND MATRIX SPIKE DUPLICATES

MS/MSD analyses measure method accuracy and precision for a project-specific matrix. A field sample is split into three portions (original, MS, and MSD) and known amounts of analytes are added (spiked) into the MS and MSD portions of the sample. The analytical results of these two portions are compared to each other for reproducibility using the RPD. These results are also compared against the unspiked portion of the sample for %R of the spiked analytes. MS/MSD samples were analyzed for all analyses.

In accordance with the QAPP, results for the affected analyte in the parent sample are qualified J for detects and UJ for nondetects if the MS/MSD %R is below the laboratory QC limits but greater than 10%. Nondetects are rejected and qualified R if %R is less than 10%. Also in accordance with the QAPP, results for the affected analyte in the parent sample are qualified J for detects if the MS/MSD %R is greater than the QC limits. No action is required for nondetects.

High recoveries were reported for TOC in the MS/MSD analyses prepared from sample FTRI031-TSO292-02-072016. TOC was detected in all samples and the results were qualified J.

Low recoveries of bromoform, carbon disulfide, cis-1,3-dichloropropene and styrene in the MS and/ or MSD were reported in the MS/MSD prepared from sample FTRI031-TSO292-02-072016. These compounds were not detected in the parent sample and the results were qualified UJ. All other MS/MSD results were acceptable or from non-site samples and were not evaluated.

3.11 FIELD DUPLICATES

Field duplicate analytical results provide information on the ability to reproduce field results and account for error introduced from handling, shipping, preparing, and analyzing field samples. One field duplicate was collected during the July 2016 groundwater sampling event, as presented in Table 3. DUP01-07/11/16 is a field duplicate of sample FTRI031-TSO292-01-072016.

The field duplicate precision criteria (RPD of less than 30%) was met for all results in the submitted duplicate pair.

3.12 DILUTIONS AND REANALYSES

All groundwater analyses were performed without dilution. No adjustments to the detection and reporting limits were required.

4.0 OVERALL ASSESSMENT

The following subsections present the field completeness, analytical data completeness, project completeness determinations, and the overall data usability for the sampling completed by HGL in July 2016.

4.1 FIELD COMPLETENESS

Field completeness for sample collection was assessed by comparing the number of samples properly collected to the number of samples planned for collection. As shown in Table 1, 4 groundwater samples were planned for collection in July 2016. All samples were collected for the designated analyses. The appropriate QC samples were also collected. Therefore, the field completeness from the July 2016 groundwater sampling event was 100%, which is above the field completeness goal of 95%.

4.2 ANALYTICAL DATA COMPLETENESS

Acceptable analytical data is a measure of laboratory contract compliance. Acceptable data includes all data that have completed the review or validation process and have not been rejected. Due to a FedEx shipping error (see Section 3.1), the overall analytical data completeness is 94%, exceeding the goal of 90%.

4.3 PROJECT COMPLETENESS

Project completeness combines sampling and analytical protocols to assess the expectations of the project as a whole. Project completeness is determined by comparing the percentage of samples/measurements that are determined to be usable to the total number of samples/measurements planned. Project completeness is calculated using the field and analytical completeness (acceptable data) percentages. Overall project completeness for the July 2016 groundwater sampling event is 94% which exceeds the project completeness goal of 90%.

5.0 CONCLUSIONS

The data are acceptable. Overall field completeness is 100% and overall analytical data completeness is 100%, both of which exceed project goals. The overall project completeness is 100% even though samples were lost during shipment and not analyzed, because the percentage is based on the completeness of field and analytical work, not on the number of samples received by the laboratory. As discussed in 3.10, minor issues with MS/MSD recoveries outside control limits were noted, leading to the qualification of some results as estimated.

6.0 REFERENCES

HydroGeoLogic, Inc. (HGL), 2014. *Site-Specific Work Plan, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations*. April.

HGL, 2015. *Revision 1 Quality Assurance Project Plan, Fort Riley, Kansas, Regional LTO/LTM for Seven Installations*. September.

Malcolm Pirnie and Burns & McDonnell, 2007. *Draft Final Remedial Design/Remedial Action Plan, 354 Area Solvent Detections (Operable Unit 005), at Main Post, Fort Riley, Kansas*. March.

U.S. Army Corps of Engineers (USACE), 2006. *Record of Decision, 354 Area Solvent Detections (Operable Unit 005), at Main Post, Fort Riley, Kansas*. June.

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TABLES

Table 1
Planned Sampling Event Summary

Well Location	Sampling Date	VOCs (SW846 8260B)	Dissolved Gases (RSK 175)	Alkalinity (SM2320 B-11)	Sulfate, Chloride, Nitrate, Nitrite (EPA 300/ SW846 9056A)	Sufide (SM4500S^{2-}-F-11)	TOC (SM5310 B-11/ SW9060A)
FTRI031-354-01-27-072016	7/11/2016	X	X	X	X	X	X
FTRI031-354-99-09-072016	7/11/2016	X	X	X	X	X	X
FTRI031-TSO292-01-072016	7/11/2016	X	X	X	X	X	X
FTRI031-TSO292-02-072016	7/11/2016	X	X	X	X	X	X

Notes:

TOC = total organic carbon

VOCs = volatile organic compounds

X = sample was analyzed by this method

Table 2
Sampling Event Detail Summary

Field Sample ID	Date Sampled	Lab Receipt	Laboratory SDG-ID	VOCs	Dissolved Gases	Alkalinity	Sulfate, Chloride, Nitrate, Nitrite	Sulfide	TOC
				(SW846 8260B)	(RSK 175)	(SM2320 B-11)	(EPA 300/ SW846 9056A)	(SM4500S^{2-}-F-11)	(SM5310 B-11/ SW9060A)
FTRI031-354-01-27-072016	7/11/2016	7/12/2016*	FA35385-6	X	X	*	*	X	X
FTRI031-354-99-09-072016	7/11/2016	7/12/2016*	FA35385-5	X	X	*	*	X	X
FTRI031-TSO292-01-072016	7/11/2016	7/12/2016*	FA35385-2	X	X	*	*	X	X
FTRI031-TSO292-02-072016	7/11/2016	7/12/2016*	FA35385-4	X	X	*	*	X	X
DUP01-07/11/16	7/11/2016	7/12/2016*	FA35385-3	X	X	*	*	X	X
TB01-07/11/16	7/11/2016	7/12/2016	FA35385-1	X	NR	NR	NR	NR	NR

Notes:

* = Analytical methods SM2320 B-11 and EPA 300/SW846 9056A were not analyzed. The cooler containing the samples was lost during shipment. When the cooler containing the samples arrived at the laboratory's Services Center in Raleigh, North Carolina (not the shipping location) on July 15, 2016 the samples were above temperature and out of hold time, so the samples were discarded.

DUP = duplicate
ID = identification
NR = not requested
SDG = sample delivery group
TB = trip blank

Table 3
Quality Control Sample Summary

Field Sample ID	QC Type	Notes
DUP01-07/11/16	Field Duplicate	duplicate of sample FTRI031-TSO292-01-072016
FTRI031-TSO292-02-072016	MS/MSD	triple volume collected
TB01-07/11/16	Trip Blank	associated with Lab SDG FA35385

Notes:

DUP = duplicate

ID = identification

MS/MSD = matrix spike/matrix spike duplicate

SDG = sample delivery group

QC = quality control

Table 4
Data Validation Qualifiers

Qualifier	Definition
No qualifier	Confirmed identification. The analyte was positively identified at the reported concentration. The reported concentration is within the calibrated range of the instrument and the result is not affected by any deficiencies in the associated QC criteria.
J	The analyte was detected at the reported concentration; the quantitation is an estimate.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria.
U	Not detected. The associated number indicates the analyte LOD.
UJ	Not detected. The associated number indicates the analyte LOD, which may be inaccurate.
X	Excluded. The data point is associated with reanalyses or diluted analyses and is excluded because another result has been selected as the definitive result for the analyte.

LOD = limit of detection

QC = quality control

Table 5
Summary of VOCs and Natural Attenuation Parameters Detected

Field Sample ID		**TB01 -07/11/16**	**FTRI031-354-01-27 -072016**	**FTRI031-354-99-09 -072016**	**FTRI031-TSO292-01 -072016**	**DUP01 -07/11/16**	**FTRI031-TSO292-02 -072016**
Laboratory SDG/ID		**FA35385-1**	**FA35385-6**	**FA35385-5**	**FA35385-2**	**FA35385-3**	**FA35385-4**
Analyte*	**MCL****						
Results in µg/L							
Benzene	**5**	0.50 U	0.50 U	0.50 U	**0.29 J**	**0.37 J**	**0.62 J**
Carbon Disulfide	810	**0.37 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	**80**	0.50 U	0.50 U	**0.31 J**	**0.65 J**	**0.58 J**	0.50 U
cis-1,2-Dichloroethylene	**70**	0.50 U	0.50 U	0.50 U	**0.84 J**	**0.78 J**	0.50 U
Ethane	-	NA	0.50 U	0.50 U	0.50 U	0.50 U	**0.33 J**
Ethylbenzene	**700**	0.50 U	0.50 U	0.50 U	0.50 U	**0.27 J**	0.50 U
Isopropylbenzene (Cumene)	450	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**3.0**
m,p-Xylene	**10000**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**1.0 J**
Methane	-	NA	0.25 U	0.25 U	**2.8**	**3.1**	**21.3**
Methylene Chloride	**5**	**8.0**	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
n-Butylbenzene	1000	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.68 J**
n-Propylbenzene	660	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.54 J**
p-Isopropyltoluene	-	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.30 J**
sec-Butylbenzene	2000	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**10.7**
tert-Butylbenzene	690	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**3.6**
Tetrachloroethylene	**5**	0.50 U	**13.7**	**13.1**	**45.1**	**44.9**	0.50 U
Toluene	**1000**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.21 J**
Trichloroethylene	**5**	0.50 U	0.50 U	0.50 U	**3.2**	**3.1**	0.50 U
Results in mg/L							
Sulfide	-	NA	**0.61 J**	**0.72**	**0.22 J**	**0.26 J**	**0.64 J**
Total organic carbon	-	NA	**1.0 J**	**0.96 J**	**1.8 J**	**1.9 J**	**3.0 J**

Notes:

*Compounds for which there is at least one reported detection in an environmental sample.

** MCL (BOLD) or Tap Water Screening Level if no MCL. Values from EPA Regional Screening Levels Summary Table (TR=1E-6, HQ=1) May 201

Bold = detected concentrations

Shading = detection above MCL

- = No MCL or Tapwater Screening Level

µg/L = micrograms per liter

DUP = duplicate

HQ = hazard quotients

ID = identification

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

MCL = maximum contaminant level

mg/L = milligrams per liter

NA = not analyzed

SDG = sample delivery group

TB = trip blank

TR = target cancer risk

U = Not detected. The associated number indicates the analyte limit of detection.

Table 6

Sampling Event Data Quality Summary

Evaluation Criteria	Limits/Requirements	Evaluation Outcome	Notes
Sample Receipt	No breakage, proper temperature, preservation	No qualifiers required	The cooler containing the sample bottles for analysis by analytical methods MS232 B-11 and EPA 300/SW846 9056A was lost during shipment. When the samples arrived at the laboratory's Service Center, the samples were above temperature and out of hold time. The samples were discarded and were not analyzed
Holding Times	Sample extraction and analysis performed within required time limits	No qualifiers required	
Tuning and Calibration	Instrument tuning and calibration within required limits	No qualifiers required	
Laboratory Method Blanks	Blanks free of contamination	No qualifiers required	
Trip Blanks	Blanks free of contamination	No qualifiers required	
Internal Standards	Internal standard recoveries within limits	No qualifiers required	
Surrogates	Surrogate recoveries within limits	No qualifiers required	
Laboratory Control Samples and Sample Duplicates	Relative percent differences in recoveries within limits	No qualifiers required	
Matrix Spike, Matrix Spike Duplicates	RPDs in recoveries within limits	TOC results qualified J in all samples; bromoform, carbon disulfide, cis-1,3-dichloropropene, and styrene qualified UJ in FTRI031-TSO292-02-072016.	High recovery of TOC and low recovery of bromoform, carbon disulfide, cis-1,3-dichloropropene, and styrene
Field Duplicates	RPDs within limits for duplicate pairs	No qualifiers required	
Field Completeness	Greater than or equal to 95%	Goal achieved	
Analytical Data Completeness	Greater than or equal to 95%	Goal achieved	
Project Completeness	Greater than or equal to 90%	Goal Achieved	

Notes:

J = The analyte was detected at the reported concentration; the quantitation is an estimate.

RPD = relative percent difference

TOC = total organic carbon

UJ =Not detected. The associated number indicates the analyte LOD, which may be inaccurate.

APPENDIX B

FIELD FORMS

- Monitoring Well Water Level Data
- Well Maintenance Form
- Low-Flow Groundwater Sampling Logs
- Field Sampling Report
- Field Equipment Calibration and Maintenance Checklist

MONITORING WELL
WATER LEVEL
DATA

HGL HydroGeoLogic, Inc.

Site: FTRI-031	Site Location: Fort Riley, KS
Field Team: A. Hedgepath	

Measurement Point: ☑ BTOC ☐ BGS ☐ Other (specify) ____________

Measurement Device: ☑ Water Level Detector ☐ Weighted Tape ☐ Other (specify) ____________

Date	Time	Well ID	PID Reading (ppm)	Well Depth (ft.)	Well SWL (ft.)	Comments/ Weather
7.11.16	1141	T50292-OC			13.46	85° Sunny
	1157	T50292-d			24.34	
	1148	354-99-09			BToP	
	1137	354-01-27			51.11	

HGL
HydroGeoLogic, Inc.

Well Maintenance Form

Site: FTRI-031

Field Team: A. Hedgepath

Date of Observation	Well ID	Well Pad	Bollards	Protective Casing	Paint	PVC	Well Cap	Lock	Down Hole Equipment	Flags	Vegetation, Rodent, Insects	Appearance	Well Label	Access	Other	Detailed Notes Regarding Well Maintenance Needs:
7.11.16	750292-01		0													Flushmount - dedicated pump
	550292-02		0													Flushmount
	354-99-09		3													
	354-01-27		3													

Check items of concern

~~14490356~~ -

~~06393434~~
~~0643522x~~

LOW-FLOW GROUNDWATER SAMPLING LOG

Site Name: FTRI-031 **Date:** 7·11·16

OVM: FID ☐ PID ☐ **In Casing (ppm):** **(Initial)** ______ **(Vented to)** Atmosphere

Well ID: TS0292-01

Purging/Sampling Device: QED SamplePro Bladder Pump [✓ Dedicated Pump]

Initial Static Water Level (feet btoc): 24.34

Analytical Parameters (circle): VOCs, TOC, MEE, Alk, Cl, NO2, NO3, Sulfide, Sulfate

Final Water Level (feet btoc): 24.63

QC Samples Collected: Dup 01-07/11/16 @ 1200

Purge Start Time: 1205

Sample Number: FTRI031-TS0292-01-072016

Sample Time: 1250

Controller Settings: Recharge: 10 **secs** **Discharge:** 5 **secs** **Pressure:** 15 **psi**

Samplers Initials: AH

Cycles Per Minute: 4

Time	Water Level (ft btoc)	Temperature (Degrees C)	pH	Specific Cond. (µs/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Comments
1215	24.40	20.67	6.27	1,589	4.36	11.1	33.5	125	
1220	24.44	19.31	6.30	1,500	2.99	0.1	21.9		
1225	24.47	18.58	6.49	1,443	1.63	-4.8	12.3		
1230	24.50	18.44	6.57	1430	1.39	-8.1	11.1		
1235	24.58	18.38	6.60	1,405	1.22	-10.7	9.32		
1240	24.59	18.94	6.63	1420	1.08	-11.8	8.91		
1245	24.60	19.25	6.64	1432	1.00	-12.1	7.42		
1250	24.63	19.44	6.64	1440	0.99	-13.5	6.98		
Final Sample Parameters									
1250	24.63	19.44	6.64	1440	0.99	-13.5	6.98	125	

AH

Casing Volume Calculations:
Water Col. X Casing Factor = Gallons per Casing Volume
Casing Factors: 2" diameter well: 0.16 / 4" diameter well: 0.65 / 6" diameter well: 1.47

PARAMETERS FOR WATER QUALITY STABILIZATION

Temperature ± 0.5 degrees Celsius	Turbidity ± 10% if > 50 NTU, or <50 NTU
pH ± 0.1 pH units	Specific Conductance ± 25 micromhos/cm, or 1%
Dissolved Oxygen ± 0.1 mg/L, or 10% if < 1 mg/L	ORP ± 10 millivolts

HGL HydroGeoLogic, Inc.

LOW-FLOW GROUNDWATER SAMPLING LOG

Site Name: FTRI-031 **Date:** 7.11.16

Well ID: 550 292 -02

Initial Static Water Level (feet btoc): ~~14~~ 13.40

Final Water Level (feet btoc): 14.10

Purge Start Time: 1330

Sample Time: 1400

Samplers Initials: AH

OVM: FID ☐ **PID** ☐ **In Casing (ppm): (Initial)** ______ **(Vented to)** Atmosphere

Purging/Sampling Device: QED SamplePro Bladder Pump / [✓ Dedicated Pump]

Analytical Parameters (circle): VOCs, TOC, MEE, Alk, Cl, NO2, NO3, Sulfide, Sulfate

QC Samples Collected: MS/MSD

Sample Number: FTRI031-550292-02-072016

Controller Settings: Recharge: 10 **secs Discharge:** 5 **secs Pressure:** 15 **psi**

Cycles Per Minute: 4

Time	Water Level (ft btoc)	Temperature (Degrees C)	pH	Specific Cond. (µs/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Comments
1340	13.80	19.01	6.86	738	0.90	-56.9	18.9	125	
1345	13.88	19.59	6.84	729	0.61	-57.0	14.3		
1350	13.96	19.97	6.82	720	0.51	-57.1	12.6		
1355	14.03	20.18	6.82	719	0.47	-61.1	11.3		
1400	14.10	20.20	6.82	717	0.44	-58.3	10.6		
Final Sample Parameters									
1400	14.10	20.20	6.82	717	0.44	-58.3	10.6	125	

Casing Volume Calculations:

Water Col. X Casing Factor = Gallons per Casing Volume

Casing Factors: 2" diameter well: 0.16 / 4" diameter well: 0.65 / 6" diameter well: 1.47

HGL

HydroGeoLogic, Inc.

PARAMETERS FOR WATER QUALITY STABILIZATION

Temperature	±0.5 degrees Celsius	Turbidity	±10% if > 50 NTU, or <50 NTU
pH	±0.1 pH units	Specific Conductance	±25 micromhos/cm, or 1%
Dissolved Oxygen	±0.1 mg/L or 10% if < 1 mg/L	ORP	±10 millivolts

LOW-FLOW GROUNDWATER SAMPLING LOG

Site Name: FTRI-031 **Date:** 7.11.16

OVM: FID ☐ PID ☐ **In Casing (ppm): (Initial)** ______ **(Vented to)** Atmosphere

Well ID: 354-01-27

Purging/Sampling Device: QED SamplePro Bladder Pump / [✓ Dedicated Pump]

Initial Static Water Level (feet btoc): 51.11

Analytical Parameters (circle): VOCs, TOC, MEE, Alk, Cl, NO2, NO3, Sulfide, Sulfate

Final Water Level (feet btoc): 51.49

QC Samples Collected: —

Purge Start Time: 1530

Sample Number: FTRI 031-354-01-27-072016

Sample Time: 1605

Controller Settings: Recharge: 10 **secs Discharge:** 5 **secs Pressure:** 27 **psi**

Samplers Initials: AH

Cycles Per Minute: 4

Time	Water Level (ft btoc)	Temperature (Degrees C)	pH	Specific Cond. (µs/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Comments
1540	51.25	21.42	6.61	798	6.30	4.7	14.2	125	
1545	51.36	21.23	6.68	738	6.05	2.3	10.1		
1550	51.43	21.16	6.71	709	5.98	2.4	9.90		
1555	51.44	20.99	6.72	692	5.92	0.9	8.86		
1600	51.46	20.96	6.73	684	5.83	0.6	8.00		
1605	51.49	20.89	6.74	680	5.79	1.0	7.41		
Final Sample Parameters									
1605	51.49	20.89	6.74	680	5.75	1.0	7.41	125	

Casing Volume Calculations:

Water Col. X Casing Factor = Gallons per Casing Volume

Casing Factors: 2" diameter well: 0.16 / 4" diameter well: 0.65 / 6" diameter well: 1.47

HGL HydroGeoLogic, Inc.

PARAMETERS FOR WATER QUALITY STABILIZATION

Temperature ±0.5 degrees Celsius
pH ±0.1 pH units
Dissolved Oxygen ±0.1 mg/L or 10% if < 1 mg/L
Turbidity ±10% if > 50 NTU, or <50 NTU
Specific Conductance ±25 micromhos/cm, or 1%
ORP ±10 millivolts

LOW-FLOW GROUNDWATER SAMPLING LOG

Site Name: FTRI-031 **Date:** 7.11.16

OVM: FID ☐ PID ☐ **In Casing (ppm): (Initial)** ______ **(Vented to)** Atmosphere

Well ID: 354-99-09

Purging/Sampling Device: QED SamplePro Bladder Pump / [✓ Dedicated Pump]

Initial Static Water Level (feet btoc): BTOP

Analytical Parameters (circle): VOCs. TOC. MEE. Alk. Cl. NO2. NO3. Sulfide. Sulfate

Final Water Level (feet btoc): BTOP

QC Samples Collected: —

Purge Start Time: 1440

Sample Number: FTRI031-354-99-09-072016

Sample Time: 1510

Controller Settings: Recharge: 10 **secs Discharge:** 5 **secs Pressure:** 25 **psi**

Samplers Initials: AH

Cycles Per Minute: 4

Time	Water Level (ft btoc)	Temperature (Degrees C)	pH	Specific Cond. (µs/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Comments
1450	BTOB	19.48	6.69	1594	6.95	5.1	5.86	125	
1455		19.33	6.71	1603	6.70	3.6	5.31		
1500		19.33	6.72	1615	6.60	3.6	4.98		
1505		19.23	6.72	1617	6.55	2.9	4.49		
1510	—	19.26	6.73	1625	6.54	2.0	4.20		
Final Sample Parameters									
1510	BTOP	19.26	6.73	1625	6.54	2.0	4.20	125	

Casing Volume Calculations:

Water Col. X Casing Factor = Gallons per Casing Volume

Casing Factors: 2" diameter well: 0.16 / 4" diameter well: 0.65 / 6" diameter well: 1.47

PARAMETERS FOR WATER QUALITY STABILIZATION

Temperature ±0 5 degrees Celsius

pH ±0 1 pH units

Dissolved Oxygen ±0 1 mg/L, or 10% if < 1 mg/L

Turbidity ±10% if > 50 NTU, or <50 NTU

Specific Conductance ±25 micromhos/cm, or 1%

ORP ±10 millivolts

HGL HydroGeoLogic, Inc.

HGL

FIELD SAMPLING REPORT

SAMPLE LOCATION: TS0292-01

PROJECT: K10 LTRA SITE: FTRI-031

SAMPLE INFORMATION

MATRIX WG

SAMPLE ID: FTRI031-TS0292-01-072016

SAMPLING METHOD SP

DUP./REP. OF: Dup001-07/11/16 @1200

BEGINNING DEPTH 24.34

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

YES ☐ NO ☑

END DEPTH 24.63

GRAB ☑ COMPOSITE ☐

DATE: 7.11.16 TIME: 1250

CONTAINER SIZE/TYPE	X	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANAYLSIS
3x40ml VOA	2	HCl		8260B	VOCs
3x40ml VOA	2	HCl		RSK 175	MEE
2x40ml Amber	2	HCl		9060A	TOC
1 L Poly	2	-		SM2320B/9056A	NO2/NO3/Sulfate/Cl/Alk
3x250ml Poly	2	NaOH ZnAC		SM4500-S-F	Sulfide

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR: Clear	
2nd	ODOR:	
	OTHER:	

pH 6.64 Temperature 19.44 Degrees C Dissolved oxygen 0.97 (mg/L) Specific Conductivity 1440 (µs/cm)

GENERAL INFORMATION

WEATHER: SUN/CLEAR ☒ OVERCAST/RAIN ☐ WIND DIRECTION W AMBIENT TEMP 90

SHIPMENT VIA: FED-X ☑ HAND DELIVER ☐ COURIER ☐ OTHER ___

SHIPPED TO: Accutest

COMMENTS:

SAMPLER: AH

OBSERVER: —

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP/WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB/WIPE	SP-SUBMERSIBLE PUMP
		PDB=PASSIVE DIFFUSION BAG	
		HY= HYDRASLEEVE	

HGL HydroGeoLogic, Inc.

FIELD SAMPLING REPORT

SAMPLE LOCATION: TS0292-02

PROJECT: K10 LTRA SITE: FTRI-031

SAMPLE INFORMATION

MATRIX WG SAMPLE ID: FTRI031-TS0292-02-0716

SAMPLING METHOD SP DUP./REP. OF: —

BEGINNING DEPTH 13.40 MATRIX SPIKE/MATRIX SPIKE DUPLICATE

[✓ YES ☒] ~~NO~~ ☒

END DEPTH 14.10

GRAB ☑ COMPOSITE ☐ DATE: 7.11.16 TIME: 1400

CONTAINER SIZE/TYPE	X	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANAYLSIS
3x40ml VOA	3	HCl		8260B	VOCs
3x40ml VOA	3	HCl		RSK 175	MEE
2x40ml Amber	3	HCl		9060A	TOC
1 L Poly	3	-		SM2320B/9056A	NO2/NO3/Sulfate/Cl/Alk
3x250ml Poly	3	NaOH ZnAC		SM4500-S-F	Sulfide

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR: Clear	
2nd	ODOR:	
	OTHER:	

pH 6.82 Temperature 20.20 Degrees C Dissolved oxygen 0.44 (mg/L) Specific Conductivity 717 (µs/cm)

GENERAL INFORMATION

WEATHER: SUN/CLEAR ☒ OVERCAST/RAIN ☐ WIND DIRECTION ~ AMBIENT TEMP 70

SHIPMENT VIA: FED-X ☑ HAND DELIVER ☐ COURIER ☐ OTHER ____

SHIPPED TO: Accutest

COMMENTS:

SAMPLER: KK OBSERVER:

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP/WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB/WIPE	SP-SUBMERSIBLE PUMP
		PDB=PASSIVE DIFFUSION BAG	
		HY= HYDRASLEEVE	

HGL HydroGeoLogic, Inc.

FIELD SAMPLING REPORT

SAMPLE LOCATION: 354-01-27

PROJECT: K10 LTRA SITE: FTRI-031

SAMPLE INFORMATION

MATRIX WG

SAMPLE ID: FTRI031-354-01-27072016

SAMPLING METHOD SP

DUP./REP. OF: —

BEGINNING DEPTH 51.11

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

YES ☐ NO ☒

END DEPTH 51.49

GRAB ☑ COMPOSITE ☐

DATE: 7.11.16 TIME: 1605

CONTAINER SIZE/TYPE	X	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANAYLSIS
3x40ml VOA	/	HCl		8260B	VOCs
3x40ml VOA	/	HCl		RSK 175	MEE
2x40ml Amber	/	HCl		9060A	TOC
1 L Poly	/	-		SM2320B/9056A	NO2/NO3/Sulfate/Cl/Alk
3x250ml Poly	/	NaOH ZnAC		SM4500-S-F	Sulfide

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR: Clear	
2nd	ODOR:	
	OTHER:	

pH 6.71 Temperature 20.89 Degrees C Dissolved oxygen 5.79 (mg/L) Specific Conductivity 680 (µs/cm)

GENERAL INFORMATION

WEATHER: SUN/CLEAR ☒ OVERCAST/RAIN ☐ WIND DIRECTION W AMBIENT TEMP 90

SHIPMENT VIA: FED-X ☑ HAND DELIVER ☐ COURIER ☐ OTHER ___

SHIPPED TO: Accutest

COMMENTS:

SAMPLER: AH

OBSERVER: —

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS WG=GROUND WATER LH=HAZARDOUS LIQUID WASTE SH=HAZARDOUS SOLID WASTE SE=SEDIMENT	SL=SLUDGE SO=SOIL GS=SOIL GAS WS=SURFACE WATER SW=SWAP/WIPE	B=BAILER BR=BRASS RING CS=COMPOSITE SAMPLE C=CONTINUOUS FLIGHT AUGER DT=DRIVEN TUBE W=SWAB/WIPE PDB=PASSIVE DIFFUSION BAG HY= HYDRASLEEVE	G=GRAB HA=HAND AUGER H=HOLLOW STEM AUGER HP=HYDRO PUNCH SS=SPLIT SPOON SP-SUBMERSIBLE PUMP

HGL

FIELD SAMPLING REPORT

SAMPLE LOCATION: 354-99-09

PROJECT: K10 LTRA   SITE: FTRI-031

SAMPLE INFORMATION

MATRIX WG

SAMPLE ID: FTRI031-354-99-09-072016

SAMPLING METHOD SP

DUP./REP. OF: —

BEGINNING DEPTH BTOP

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

YES ☐   NO ☒

END DEPTH BTOP

GRAB ☑   COMPOSITE ☐

DATE: 7-11-16   TIME: 1510

CONTAINER SIZE/TYPE	X	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANAYLSIS
3x40ml VOA	1	HCl		8260B	VOCs
3x40ml VOA	1	HCl		RSK 175	MEE
2x40ml Amber	1	HCl		9060A	TOC
1 L Poly	1	-		SM2320B/9056A	NO2/NO3/Sulfate/Cl/Alk
3x250ml Poly	1	NaOH ZnAC		SM4500-S-F	Sulfide

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR: Clear	
2nd	ODOR:	
	OTHER:	

pH 6.73   Temperature 19.26 Degrees C   Dissolved oxygen 6.54 (mg/L)   Specific Conductivity 1625 (µs/cm)

GENERAL INFORMATION

WEATHER: SUN/CLEAR ☒ OVERCAST/RAIN ☐ WIND DIRECTION W AMBIENT TEMP 76

SHIPMENT VIA: FED-X ☑ HAND DELIVER ☐ COURIER ☐ OTHER ____

SHIPPED TO: Accutest

COMMENTS:

SAMPLER: AH   OBSERVER: —

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP/WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB/WIPE	SP-SUBMERSIBLE PUMP
		PDB=PASSIVE DIFFUSION BAG	
		HY= HYDRASLEEVE	

Field Equipment Calibration and Maintenance Checklist

EQUIPMENT MAINTENANCE AND CALIBRATION RECORD

Contract/Project: FTRI-031
Activity: Groundwater Sampling
Equipment Description: Hanna Turbidity Meter HI 98703
Equipment ID: 0645224
Equipment Serial No.: 06393434

Calibration Date/Time	Parameter	Standard Used (Concentration)	Lot Control No./ Expiration Date	Post Calibration Reading	Comments Pass/Fail	Signature
7-11-16 1100	Turbidity	0.1	0.1	C579989 09/16		
		15	15	C577452 09/16		
		100	100	C579989 09/16		
		750	750	C583094 09/16	✓ pass	
	Turbidity	0.1				
		15				
		100				
		750				
	Turbidity	0.1				
		15				
		100				
		750				

Notes/Maintenance Performed:

HGL

Field Equipment Calibration and Maintenance Checklist

EQUIPMENT MAINTENANCE AND CALIBRATION RECORD

Contract/Project: FTRI-031
Activity: Groundwater Sampling

Equipment Description: YSI 556
Equipment ID: — (Display Unit) & (Probe Unit)
Equipment Serial No.: 14C100355 (Display Unit) & (Probe Unit)

Calibration Date/Time	Parameter	Standard Used (Concentration)	Lot Control No./ Expiration Date	Post Calibration Reading	Comments Pass/Fail	Signature
7.1.16 1100	PH	pH 4.0 pH 7.0	E362-04 12/17 F069-19 4/18	4.0 7.0	✓	
	ORP	Zorbell Solution 237.5 mV @ °C	16D00057 4/21	237.5		
	Conductivity	1409 µs/cm	E231-17 8/17	1409		
	DO	Air 100% Saturation		100%	Pass	
	PH	pH 4.0 pH 7.0				
	ORP	Zorbell Solution mV @ °C				
	Conductivity	1409 µs/cm				
	DO	Air 100% Saturation				
	PH	pH 4.0 pH 7.0				
	ORP	Zorbell Solution mV @ °C				
	Conductivity	1409 µs/cm				
	DO	Air 100% Saturation				

Notes/Maintenance Performed:

APPENDIX C

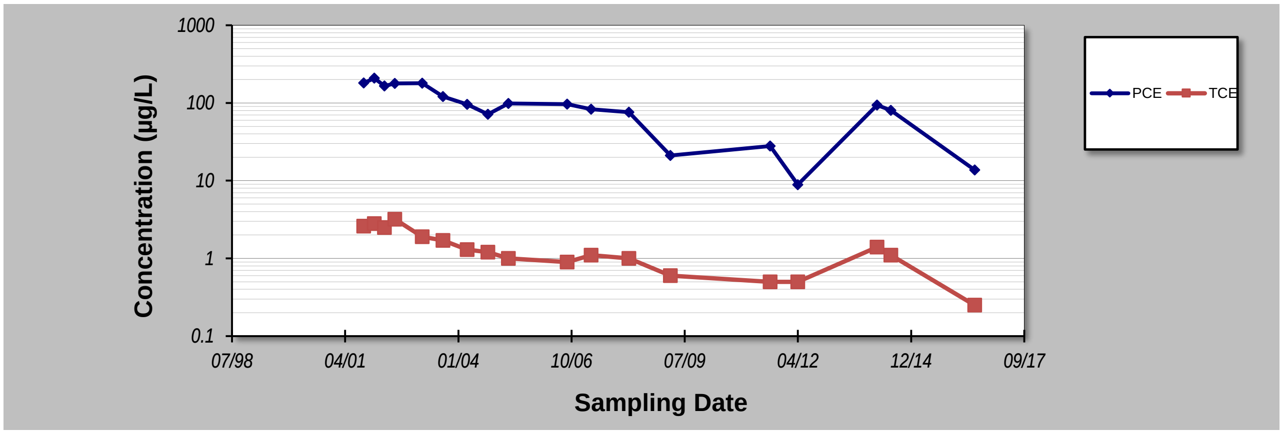
MANN-KENDALL TREND ANALYSIS

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **354-01-27**
Concentration Units: **μg/L**

Sampling Point ID:		**PCE**	**TCE**					
Sampling Event	Sampling Date	354-01-27 CONCENTRATION (µg/L)						
1	10/01/01	**181**	**2.6**					
2	01/01/02	**208**	**2.8**					
3	04/01/02	**166**	**2.5**					
4	07/01/02	**179**	**3.2**					
5	03/01/03	**180**	**1.9**					
6	09/01/03	**121**	**1.7**					
7	04/01/04	**95.9**	**1.3**					
8	10/01/04	**71.7**	**1.2**					
9	04/01/05	**98.5**	**1**					
10	09/01/06	**96.6**	**0.9**					
11	04/01/07	**82.9**	**1.1**					
12	03/01/08	**76.1**	**1**					
13	03/01/09	**21.1**	**0.6**					
14	08/01/11	**28**	0.5					
15	04/01/12	**8.9**	0.5					
16	03/01/14	**94.1**	**1.4**					
17	07/01/14	**80.5**	**1.1**					
18	11-Jul-16	**13.7**	0.25					
19								
20								
Coefficient of Variation:		**0.62**	**0.61**					
Mann-Kendall Statistic (S):		**-107**	**-106**					
Confidence Factor:		**>99.9%**	**>99.9%**					
Concentration Trend:		Decreasing	Decreasing					



Notes:

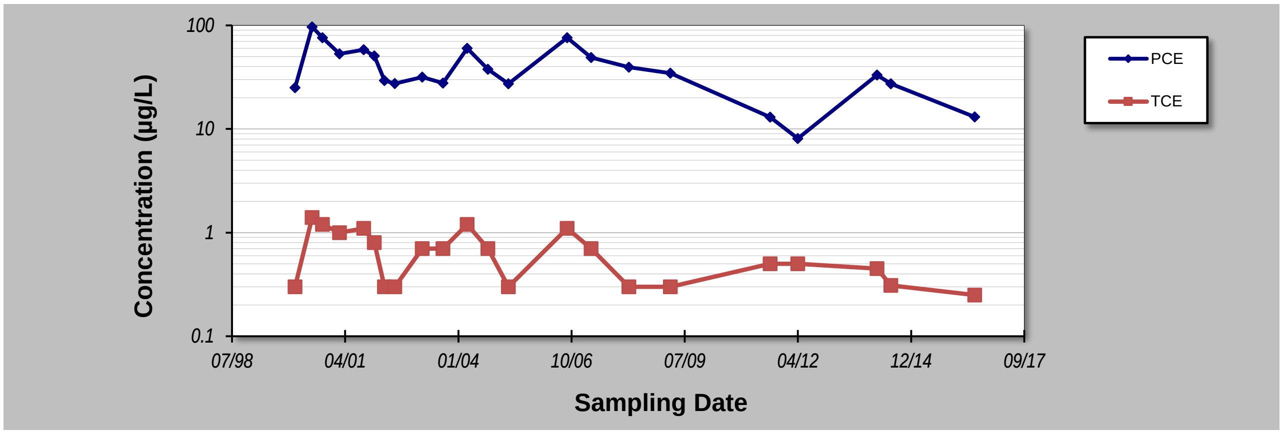
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **354-99-09**
Concentration Units: **µg/L**

Sampling Point ID:		**PCE**	**TCE**					
Sampling Event	Sampling Date	354-99-09 CONCENTRATION (µg/L)						
1	2/1/2000	**25.1**	0.3					
2	7/1/2000	**96.8**	**1.4**					
3	10/1/2000	**75.9**	**1.2**					
4	03/01/01	**53.2**	**1**					
5	10/01/01	**58.2**	**1.1**					
6	01/01/02	**50.8**	**0.8**					
7	04/01/02	**29.3**	0.3					
8	07/01/02	**27.5**	0.3					
9	03/01/03	**31.7**	**0.7**					
10	09/01/03	**27.7**	**0.7**					
11	04/01/04	**60**	**1.2**					
12	10/01/04	**37.8**	**0.7**					
13	04/01/05	**27.3**	0.3					
14	09/01/06	**75.9**	**1.1**					
15	04/01/07	**49**	**0.7**					
16	03/01/08	**39.4**	0.3					
17	03/01/09	**34.5**	0.3					
18	08/01/11	**13**	0.5					
19	04/01/12	**8.1**	0.5					
20	03/01/14	**33.1**	**0.45**					
21	07/01/14	**27.3**	**0.31**					
22	7/11/2016	**13.1**	0.25					
23								
24								
25								
Coefficient of Variation:		**0.55**	**0.56**					
Mann-Kendall Statistic (S):		**-87**	**-87**					
Confidence Factor:		**99.3%**	**99.3%**					
Concentration Trend:		Decreasing	Decreasing					



Notes:

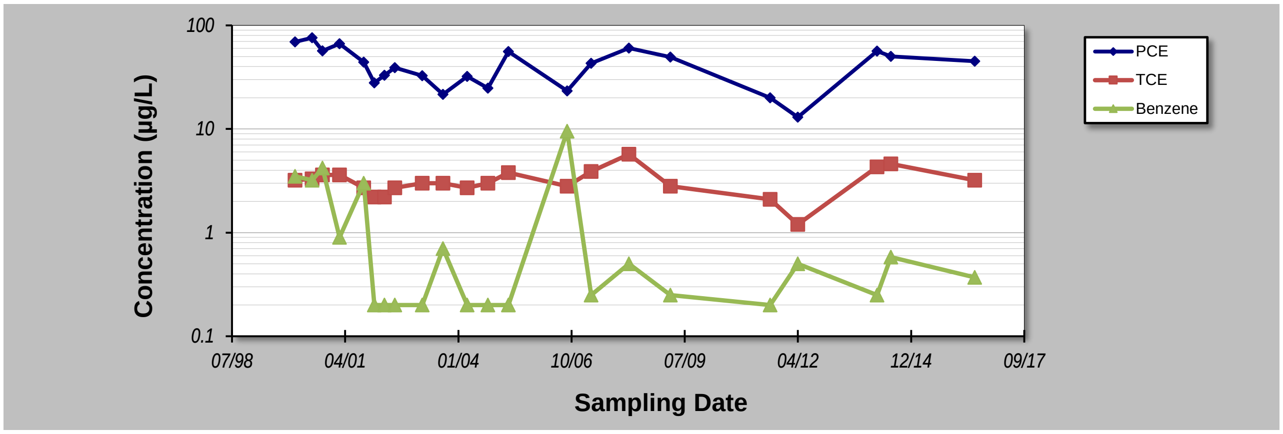
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **TS0292-01**
Concentration Units: **µg/L**

	Sampling Point ID:	PCE	TCE	Benzene				
Sampling Event	Sampling Date	TS0292-01 CONCENTRATION (µg/L)						
1	2/1/2000	69.3	3.2	3.5				
2	7/1/2000	75.9	3.3	3.2				
3	10/1/2000	56.8	3.6	4.2				
4	03/01/01	66.5	3.6	0.9				
5	10/01/01	44.2	2.7	3				
6	01/01/02	27.9	2.2	0.2				
7	04/01/02	33	2.2	0.2				
8	07/01/02	39	2.7	0.2				
9	03/01/03	32.6	3	0.2				
10	09/01/03	21.6	3	0.7				
11	04/01/04	32.1	2.7	0.2				
12	10/01/04	24.8	3	0.2				
13	04/01/05	55.8	3.8	0.2				
14	09/01/06	23.3	2.8	9.5				
15	04/01/07	43	3.9	0.25				
16	03/01/08	60.4	5.7	0.5				
17	03/01/09	49.5	2.8	0.25				
18	08/01/11	20	2.1	0.2				
19	04/01/12	13	1.2	0.5				
20	03/01/14	56.6	4.3	0.25				
21	07/01/14	50.1	4.6	0.58				
22	11-Jul-16	45.1	3.2	0.37				
23								
24								
25								
	Coefficient of Variation:	0.41	0.30	1.66				
	Mann-Kendall Statistic (S):	-57	23	-31				
	Confidence Factor:	94.2%	73.0%	79.9%				
	Concentration Trend:	Prob. Decreasing	No Trend	No Trend				



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

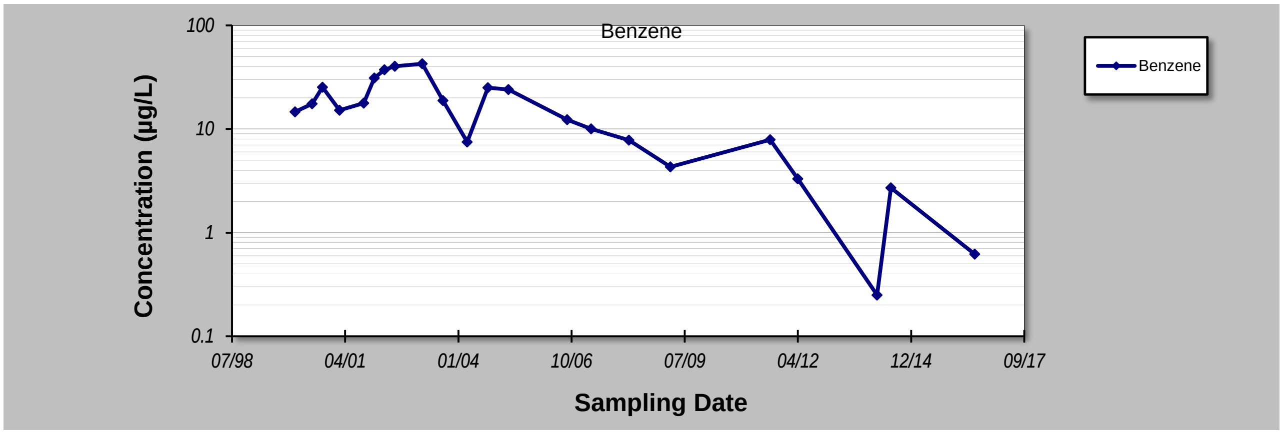
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **15-Aug-16**
Facility Name: **HydroGeoLogic, Inc.**
Conducted By: **ECU**

Job ID: **FTRI-031**
Constituent: **TS0292-02**
Concentration Units: **µg/L**

Sampling Point ID: **Benzene**

Sampling Event	Sampling Date	TS0292-02 CONCENTRATION (µg/L)						
1	2/1/2000	**14.6**						
2	7/1/2000	**17.5**						
3	10/1/2000	**25.3**						
4	03/01/01	**15.2**						
5	10/01/01	**17.8**						
6	01/01/02	**31**						
7	04/01/02	**37.4**						
8	07/01/02	**40.3**						
9	03/01/03	**42.6**						
10	09/01/03	**18.8**						
11	04/01/04	**7.5**						
12	10/01/04	**25**						
13	04/01/05	**24**						
14	09/01/06	**12.3**						
15	04/01/07	**10**						
16	03/01/08	**7.8**						
17	03/01/09	**4.3**						
18	08/01/11	**7.9**						
19	04/01/12	**3.3**						
20	03/01/14	0.25						
21	07/01/14	**2.7**						
22	7/11/2016	**0.62**						
23								
24								
25								
Coefficient of Variation:		**0.77**						
Mann-Kendall Statistic (S):		**-117**						
Confidence Factor:		**>99.9%**						
Concentration Trend:		Decreasing						



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

Vapor Intrusion Technical Memorandum

Addendum to the 3rd Five-Year Review Report

For Fort Riley, Kansas

June 2013

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List of Acronyms and Abbreviations

ASTM	American Society of Testing and Materials
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CFR	Code of Federal Regulations
COPC	Chemical of Potential Concern
DCE	Dicholorethylene
EPA	Environmental Protection Agency
HEAST	Health Effects Assessment Summary Tables
HHBLRA	Human Health Baseline Risk Assessment
HI	Hazard Index
IRIS	Integrated Risk Information System
KDHE	Kansas Department of Health & Environment
PCE	Tetracholorethylene or Perchloroethylene
PID	Photo-Ionization Detector
QA	Quality Assurance
RAGS	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RSK	KDHE Risk-Based Standard
TCE	Trichloroethylene
ug/kg	microgram per kilogram
ug/L	microgram per liter
ug/m^3	microgram per cubic meter
VC	Vinyl Chloride
VOC	Volatile Organic Compound

1.0 Introduction

This technical memorandum is being developed to address a concern that there may be a potential vapor intrusion issue that is affiliated with building 367 within the 354 Area Solvent Detections Operable Unit 005 (OU 005) (354) at Fort Riley, Kansas. The issue was raised during the installation's 3rd Five-Year Review effort being conducted pursuant to 40 Code of Federal Regulations (CFR) 300.430(f) (4) (ii).

2.0 Building History and Condition

Building 367 was constructed in 1903 as a gun shed to house horse-drawn artillery pieces in bays. It is a one-story building constructed of coursed, ashlar limestone on a limestone foundation with an on-grade, concrete slab floor. It is a contributing building to the National Register of Historic Places Main Post Historic District in the Cavalry and Artillery thematic group. Its later history was conversion to a motor pool and finally to general storage which is its present use. The building originally had large swing-out doors but those have been converted to the more modern, roll-up style, garage doors. There are numerous penetrations throughout the building's structure. Some examples are large-area chimney vents for old style, gas, space heaters that are extant but not in use, an attic, door openings without doors that interconnect to other bay areas, and loose fitting, bay doors and older windows that are not tight. These conditions permit extensive air exchange and movement within the structure. The building's current purpose as general storage has it containing motorized equipment and a wide variety of containerized products that have the potential to volatilize. Finally, the building is not occupied on a continuous or long-term basis. It is commonly occupied for a few minutes to a few hours on an irregular, limited basis by a limited number of personnel. Additionally, the building is completely surrounded by asphalt pavement that is nominally 8-inches thick. See images of this building in the Appendix to this document.

3.0 Site Condition and History

As noted previously, Building 367 is within the boundary of the 354 site. This operable unit has undergone extensive characterization as a result of the presence of contamination by hazardous substances listed per the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The principal contaminant is tetrachloroethylene (PCE). To properly address site characterization, a complete Remedial Investigation (RI) was completed November 3, 2003. A Human Health Baseline Risk Assessment (HHBLRA) was conducted as a component of the RI and is found in Chapter 7 of that document.

3.1 Human Health Baseline Risk Assessment

The HHBLRA addressed both the future indoor worker and the future utility worker scenarios. It specifically noted in Chapter 7 Section 7.1.2 of the RI that it followed the procedures outlined in EPA's *Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual Part A* (USEPA, 1989) and other EPA guidance documents that were cited throughout the text. The building 367 area was one of three source areas that were addressed.

The following chemicals were selected as Chemicals of Potential Concern (COPCs) for subsoil:

PAHs
Acenaphthylene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Indeno(1,2,3-cd)pyrene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Naphthalene
Phenanthrene
Pyrene
Benzo(g,h,i)perylene

Volatiles
Acetone
Carbon disulfide
Trichloroethylene (TCE)
PCE
trans-1,2-Dichloroethylene(DCE)
m & p Xylenes
cis-1,2-Dichloroethylene

The following chemicals were selected as COPCs for ground water:

Volatiles
1,1,2-Trichloroethane(TCA)
Carbon tetrachloride (CCL_4)
Chloroform
cis-1,2-DCE
PCE
trans-1,2-DCE
TCE
Vinyl chloride (VC)

For the risk assessment work, the toxicity of the COPCs is evaluated for carcinogenic and non-carcinogenic potential to produce adverse health effects. The data regarding health effects are used to determine numerical toxicity values. The primary source for the toxicological information utilized for the RI was the EPA sponsored *Integrated Risk Information System* [IRIS] or the EPA's *Health Effects Assessment Summary Tables* [HEAST] .

The entire set of protocols for deriving non-carcinogenic and carcinogenic effects was laid out in Section 7.3.1 and Section 7.3.2 of the RI. Tables 7-11, 7-12, and 7-13 from the RI are presented in the Appendix for this document to provide the pertinent data regarding the values utilized. Appendix 7C from the RI contains the Vapor Modeling that was conducted for the modeling the migration of chemical vapors from soil, soil gas, and ground water and is found in the Appendix of this document. It was used to estimate vapor concentrations in indoor and outdoor air.

The next step in the RI was to develop exposure assessments and those are found in Section 7.4. The potentially exposed populations and potential exposure pathways are identified. The site physical features, land use, and zoning are considered in order to ascertain pathways and population for which exposure may exist. The only exposure pathways considered are those that are completed. Current and future land use and current and future water use were two of the criteria evaluated based against potentially exposed populations. The building 367 area population exposures were current and future indoor worker employed within the building and future utility excavation worker. As the area is under pavement, as noted earlier, a groundskeeper was unlikely to be exposed so it was not evaluated. The worst-case scenario using the current site conditions were the basis for the determinations.

The current or future indoor worker was unlikely to have incidental ingestion of impacted soil based on the fact that the entire area is paved. Chemical vapors from the volatile organic compounds (VOCs) could potentially migrate into the building and into the worker's breathing zone which would lead to potential exposure by inhalation.

The future utility excavation worker could have direct contact with soils. The direct contact with the contaminated soils could lead to incidental ingestion from the disturbed soils or chemical adsorption through dermal contact. There is the potential of VOCs being present in the breathing zone of the worker that would lead to the inhalation of vapor phase of the chemicals. Table 7-14 from the RI presented the pathways considered in the human health risk assessment and is included in the Appendix.

Exposure variables are used to established values to yield a reasonable maximum exposure (RME). The RME is representative of a high-end exposure situation but still in the range of potential exposure levels. The Section 7.4.4 Estimation of Intake, Sections 7.4.4.1 Exposure Variables, and 7.4.4.2 Chemical Variables were presented in the RI.

The next step in the process is to do the risk characterization. That involves quantification of the potential risks by exposure to chemicals through the identified pathways. The intake of each chemical is combined mathematically with the appropriate toxicity value to estimate the likelihood of health risks. The risk characterization is provided in two segments. There are non-carcinogenic and carcinogenic aspects for each exposure pathway and scenario. These are covered in detail in Section 7.5 of the RI.

The risk estimates for the Future Indoor Worker Scenario for the building 367 area are as follows:

- The non-carcinogenic value for inhalation of chemical vapors in this pathway resulted in a total hazard index of 3E-04 which is significantly below the EPA risk value of a hazard index greater than one
- The carcinogenic value for excess cancer risk was 2E-07 which is below the 1E-04 to 1E-06 acceptable risk range.

The risk estimates for the Future Utility Excavation Worker Scenario are as follows:

- The non-carcinogenic value for incidental ingestion was a hazard index of 8E-05. The value for dermal contact was a hazard index of1E-07. The value for inhalation of fugitive dust was a hazard index of 5E-10. The value for inhalation for chemical vapors was a hazard index of 2E-05. The total hazard index was 1E-04. All of those values are significantly below the hazard index of one.

- The carcinogenic value for soil through incidental ingestion was 2E-08. The value for dermal contact was 2E-09. The value for inhalation of fugitive dust was 2E-13. The value for inhalation of vapor phase was 2E-08. The total excess lifetime cancer risk was 4E-08. This is well below the 1E-04 to 1E-06 established by the EPA.

The HHBLRA results indicate that the excess cancer risks for all populations were below the EPA's allowable levels. The hazard indices for all the populations were also below the EPA's level of concern. The RI Table 7-44 presents that data & is included in the Appendix.

3.2 Indoor Air Sampling

Two indoor air sampling events were conducted in February and April of 2003.

During the first event, samples were taken from seven buildings at Fort Riley. A total of 14 samples were taken of ambient air in evacuated one-liter summa canisters continuously over an eight-hour period. One duplicate and one QA sample were taken in the same location and at the same time as one of the samples. The samples were shipped to Precision Analytical in Phoenix, Arizona. They were analyzed by Method TO-15 for a Target Analyte List of vinyl chloride, 1,1-DCE, trans-1,2-DCE, cis-1,2-DCE, carbon tetrachloride, TCE, and PCE. The Quality Control Summary Report (QCSR) dated March 2003 stated that carbon tetrachloride was detected at concentrations ranging from 0.53 ug/m^3 to 0.63 ug/m^3 in all the samples. The samples for this investigation were taken from sites where carbon tetrachloride was found and from where it was not found. Consistent detections at the same concentration tend to indicate laboratory contamination. A photo-ionization detector (PID) was used as part of the safety plan to screen ambient air during sample collector setup and disassembly. This detector would register PCE, TCE, and cis-1,2-DCE at the concentrations detected in the air samples. The concentrations were as high as 150 ug/m^3. See Tables 7A through 7D in the Appendix. Based on the ubiquitous detection of carbon tetrachloride at constant concentrations in the Summa canisters and the failure of the PID to detect concentrations of compounds found in the laboratory analysis, all the data are questionable. As a result, the data are rejected based on the following: "Sample 022603-366-01 was a QA sample sent to a different laboratory for analysis. Table 6 illustrates that the QA laboratory produced significantly different results compared to the primary laboratory...Based on the QA results not being comparable to the primary sample and its duplicate, it was determined that no useful data could be drawn from this investigation." Table 6 from this report is included in the Appendix of this document.

During the second event, samples were taken from seven buildings at Fort Riley. A total of 14 samples were taken of ambient air in evacuated one-liter summa canisters continuously over an eight-hour period. One duplicate and one QA sample were taken in the same location and at the same time as one of the samples. The QA sample was sent to a different laboratory for analysis. The QCSR dated June 2003 stated that the QA laboratory produced significantly different results compared to the primary laboratory. Based on the QA results not being comparable to the primary sample and its duplicate, it was determined that no useful data were obtained from the investigation. See Tables 6A through 6D in the Appendix.

3.3 2004 Pilot Study for Soil Remediation

A pilot study effort was conducted from March 2004 to March 2005 adjacent to building 367. Figure 1-3 (included in the Appendix) from the *Pilot Study Report Pilot Study for Soil Remediation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas* dated June 28, 2005 depicts the site and treatment area.

The objectives of the pilot study included:

- The evaluation of potassium permanganate oxidation and in-situ mixing as a viable technical option for treatment of shallow, chlorinated solvent contaminated areas
- The reduction of soil contamination within the treatment area to concentration below the KDHE Risk-Based Standards (RSKs). The target was 180 micrograms per kilogram (ug/kg) of PCE for the soil-to-ground-water pathway (residential scenario). The cleanup goal for TCE was 200 ug/kg and the goal for cis-1,2-DCE was 800 ug/kg.

The treatment area was located on the east side of building 367 within 5-feet of the building in Figure 1-3 from the Pilot Study Report and shown in the Appendix to this document. The surface area was approximately 40-feet x 70-feet and the subsurface area was from immediately below the pavement (ground surface) to about 10-feet below ground surface (bgs). PCE was the main constituent of the contamination on site. A large number of GeoProbe borings had established levels ranging from as high as 29,000 ug/kg to as low as 6.9 ug/kg for PCE. TCE values ranged from 756J ug/kg to 6.7 ug/kg. cis-1,2-DCE ranged from 8,120J ug/kg to 6.3 ug/kg.

Permanganate is commercially available as a salt of potassium or sodium. The primary difference is based on solubility. Potassium permanganate is less soluble than sodium permanganate. It was decided to utilize potassium permanganate. After evaluating site conditions, in-situ soil mixing was selected as the treatment option based on the relatively shallow depth of the contamination. It was decided to use the Lang Tool LTC-290 blender. (See the color image of the tool in operation mixing the permanganate in the soil at the site in this Appendix.) It is capable of mixing dry soil as well as saturated and sludge material to a treatment depth of approximately 18-feet below grade. The deep digger blender attachment can develop 20,000 pounds-foot of torque. The results were an effective mixing of contaminated soil and potassium permanganate.

Post-treatment confirmation soil sampling was conducted to determine the effectiveness of the in-situ soil treatment. The samples were collected using direct-push equipment to advance boring through treated and untreated soils. The original plan was to sample nine specified locations, but as a result of the treated soils not dewatering sufficiently only eight locations were occupied. Seven soil samples were obtained at each direct-push location to a maximum depth of 44-feet. The samples taken at 20'-24', 30'-34', and 40'-44' were untreated soil. Sampling was done in 8 girds. Grids 5, 6, 12, and 16 had PCE detections above the KDHE RSK standard of 180 mg/kg in the 40'-44' interval. Grids 10, 12, and 16 had PCE detections above the KDHE RSK in the 30'-34' interval. The rest of the girds were below the standard. The TCE and cis-1,2-DCE results were all below their respective standards. Tables 3-2 and Figure 2-1 are included in the Appendix of this document for clarification.

Following an evaluation of the confirmation soil sampling results, it was determined that post-treatment PCE concentrations were elevated above the RSK of 180 ug/kg. Another factor was the treated soil remained highly saturated from the water used to inject the potassium permanganate. It was decided that additional treatment was required. Upon consideration of the circumstances, it was felt that additional treatment with more water would only exacerbate the situation, therefore, more treatment with permanganate was ruled out. The decision was made to establish a temporary land-farm area, excavate the saturated soil, transport it to the land farm, and disk the material to improve volatilization of the chlorinated solvents. The disking transpired at intervals of approximately every two weeks. Twelve confirmation samples were taken from the land farm 17 days after the 3rd disking event. Soil samples were submitted to an off-site, analytical laboratory. The PCE results were from 9.7J to non-detect, TCE was not detected, and cis-1,2-DCE results were from 12.9J ug/kg to non-detect. The soil was removed from the land farm and utilized as cover material at the Campbell Hill Construction/Demolition Landfill on the installation.

The open excavation that remained after the removal of the saturated soil adjacent to building 367 was backfilled with clean soil from an on-post borrow site. Two discrete samples were obtained from the borrow source for geotechnical analysis prior to beginning soil compaction activities. The backfill was placed in the excavated area in lifts of maximum loose thickness of 8-inches and compacted to 95 percent of ASTM D698 maximum dry density. After completing the backfilling operations, the surface area, with an additional 2-feet of pavement removal to improve the seal, was repaved.

3.4 Soil-Gas Investigation

A soil-gas investigation was conducted in 2004 around eight buildings in the Main Post Historic District. The objective of this soil-gas investigation was to determine if elevated levels of soil gas were present in the subsurface soils immediately adjacent to those buildings. The analytes of interest were those chlorinated solvents that had been detected in the ground-water plume. Those chemicals are PCE, TCE, cis-1,2-DCE, and carbon tetrachloride. The data are to assist in determining if the indoor air quality could be degraded and, therefore, be a risk to building occupants.

The original intent was to collect samples at three locations around each structure. These were to be located 'side gradient' and 'up gradient' with respect to the general direction of flow of ground water in the terrace aquifer which is approximately north to south. The direct-push borings would be northwest, northeast, and southwest of each structure within three to six-feet of exterior walls. There were some adjustments imposed by sites conditions such as utilities, decorative vegetation, or other factors.

At each direct-push boring location, the planned effort was to collect seven soil-gas samples at depths of 5, 10, 15, 20, 30, 40, and 50-feet below ground surface (bgs). There was one refusal at the depth of 50-feet at building 367. The direct-push equipment was composed of probe rods with a threaded point holder and disposable point that were pushed hydraulically to the desired sampling depths. Polyethylene tubing was then lowered down the probe rods and threaded into the point holder. The rods were then retracted to create a void in the soil and the drive point disengaged. A vacuum was applied to purge the tubing and draw a soil-gas sample. The soil gas was then withdrawn using a disposable syringe and immediately injected into a Shimadzu GC-14A gas chromatograph for analysis. The soil-gas samples were analyzed only for the previously enumerated chlorinated solvents.

A total 23 samples were taken or attempted at the building 367 location. One was a duplicate sample, one was a re-analysis, and there was one refusal at 50-feet. cis-1,2-DCE was detected in three samples with a range of 1.5J to 2.6 ug/L. TCE was not detected in reportable quantities. PCE was detected in 12 samples ranging from 1.9J to 236 ug/L. The two elevated values were 236 ug/L at 10-feet and 145 ug/L at 15-feet. These higher hits were located on the southwest, down-gradient side of building 367 next to the triangle A . See Figure 1-1 and Table 2-1 (continued) from the report in this Appendix.

The study concluded that there could be, not that it did, pose an issue with indoor air quality based on those two hits out of 23 samples. The action taken was to instruct occupants to open garage doors on the west side of the building and ventilate the workspace during use.

4.0 Risk Discussion

Fort Riley has completed the third five-year review of the remedial action implemented by the Record of Decision and the Remedial Action Plan. While vapor intrusion releases and exposure were not anticipated or addressed in the initial selection of the remedial action, Fort Riley has been requested to address such issues as a result of the five-year review.

The remedy was selected before the US Environmental Protection Agency (EPA) released new risk assessment guidance which now addresses some of the related issues, such as its Supplemental Guidance for Inhalation Risk Assessment (Part F of Risk Assessment Guidance for Superfund: http://www.epa.gov/oswer/riskassessment/ragsf/index.htm), its Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSLs: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm), and 2012 Vapor Intrusion (VI) Frequently Asked Questions (FAQs: http://www.epa.gov/superfund/sites/npl/Vapor_Intrusion_FAQs_Feb2012.pdf).

In this exercise, the RSL calculator is used with some building specific exposure assumptions and the inhalation reference concentration (RfC) for non-cancer toxicity and the inhalation unit risk (IUR) for cancer from EPA's Integrated Risk Information System (IRIS) to calculate building specific air screening levels. The RSL calculator's default cancer risk of 1E-01 (1/1,000,000) and a hazard quotient of 1 have not been changed for this calculation.

The building specific exposure assumptions provided by Fort Riley personnel and used in these calculations are:

- Exposure frequency: 30 days/year,
- Exposure duration: 1 year, and
- Exposure time: 1 hour/day.

Using these assumptions and inputs, a non-cancer screening level of 1.17 E+04 μg/m^3 and a cancer risk screening level of 7.86 E+04 μg/m^3 are calculated as shown in the attached output using these inputs with the RSL calculator. The lower of these two values 1.17 E+04 (11,700) μg/m^3 based upon non-cancer toxicity is then used.

Fort Riley personnel have collected soil-gas samples from sub-surface soil 10' beneath the building used for storage and only occasionally visited by its personnel. The most significant (highest risk) level of contamination found in the soil gas was a maximum concentration of 236 μg/l tetrachloroethylene (PCE). EPA air-screening levels and air-toxicity values are presented in μg/m^3. 236 μg/l is 236,000 μg/m3. Using the default attenuation factor of 0.1 provided in the 2012 FAQ for soil gas to indoor air would be expected to attenuate (e.g. reduce) the measured concentration of 236,000 μg/m^3 to 23,600 (2.36E+04) μg/m^3.

The attenuated measured concentration of 23,600 μg/m^3 is thus approximately twice as large as the calculated building specific screening level of 11,700 μg/m^3 which is based upon non-cancer toxicity, and represents a hazard quotient (a measure of non-cancer toxicity) of about 2 [*since the non-cancer screening level was lower than the cancer screening level, the non-cancer screening level was used. The attenuated measured concentration of 23,000 μg/m^3 represents an excess lifetime cancer risk of about 3.0E-07 well below the CERCLA protective cancer risk range of E-04 to E-06.*]. The default hazard quotient used by EPA is 1, above which non-cancer effects can sometimes occur. However, the default attenuation (soil gas to indoor air) factor of 0.1 is considered highly conservative for the environmental setting of this building in view of the silt soils surrounding the building and because no PCE was detected closer to the building's slab than at a depth of the 5'. It should also be noted that this building is not "tightly sealed" and is highly ventilated, which would tend to quickly exhaust any contamination entering the building. In view of these factors, an exceedance by the attenuated measured air concentration by a factor of about two above the building specific screening level is not believed to represent a potentially significant risk to persons occasionally visiting or entering this building.

The following bullets address the pertinent facts with regard to the site, its condition, and the issues:

- The RI and its HHBLRA that investigated the impact to an indoor worker stated that the non-carcinogenic risk was 3E-04 with the HI of 1 or greater posing a risk and the carcinogenic risk was 2E-07 with a range of 1E-04 to 1E-06 being the regulatory level for risk concern. See Table 7-44 in this Appendix
- The RI and its HHBLRA that investigated the impact to a utility worker in a trench with direct exposure to the site contaminants stated the non-carcinogenic risk was 1E-04 with the HI of 1 or greater posing a risk and the carcinogenic risk was 4E-08 with a range of 1E-04 to 1E-06 being the regulatory level for risk concern. See Table 7-44 in this Appendix
- The potential source for continuous input to soil gas was removed by the pilot study remedial action in 2004.
- The ground-water concentrations of PCE have steadily decreased in the two monitoring wells nearest the building 367 site since the treatment and removal of the contaminated soil adjacent to the building. See the Technical Memorandum Concentrations Table in this Appendix.
- The soil-gas study had only two hits of concern below 8-inches of asphalt in fine-grained soils 10-feet and 15-feet bgs out a sample populations of 23. This a statistically small percentage upon which to base a concern.
- The screening levels applied to the site are generic, are utilized without site-specific data, are based on exposure over a lifetime, and are ultraconservative.
- The inhalation exposure carcinogenic RfC value for PCE has been altered to a less toxic value. The value was 5.90E-06 per ug/m^3 and is now 2.6E-07 per ug/m^3.
- The building is in a designated industrial use area and a residential or office setting is not viable as a reasonably anticipated land use scenario for this type of

building. The alteration of this historic structure would require securing agreement with the State Historic Preservation Office and such extensive modification would potentially be viewed as an adverse impact and not permitted.

- The KDHE has an indoor air value for a residential setting. The calculations are predicated on an exposure frequency of 350 days per year and an exposure duration of 30 years to arrive at an adult cancer risk. The averaging time is 70-years. The inhalation unit risk factor is chemical specific. The exposure frequency and duration are outside what would be a reasonable maximum exposure scenario for the building.

5.0 Summary and Recommendations

The concern was raised that the site and its circumstances might necessitate a vapor intrusion study based on two values obtained in a 2004 soil-gas study. The data presented in the preceding discussion section are indicative of a lack of a reasonable potential for a vapor intrusion issue to exist for the building.

The potential source was removed in a remedial action and the area backfilled with clean soil and re-paved, the ground-water concentrations in nearby monitoring wells are continuing to decrease, and the building's lack of a long-term or continuous human presence supports the contention that no evidence supports the existence of a pathway that would dictate the need to conduct any further studies.

The decrease in the level of toxicity of PCE, the building's many penetrations that do not permit accumulation of vapors, and the lack of potential that the building will be used to house office spaces or other enclosed sensitive functions are further substantiation that there is no supportable reason to be concerned about vapor intrusion or build up.

Based on the data that are presented in the technical memorandum, the physical criteria at the site with regard to the building, its structure and conditions, the 8-inch thick pavement, soil characteristics, and the removal of the contaminated soils, a vapor intrusion pathway cannot be demonstrated to be a viable consideration. The installation does not find it an acceptable approach to expend funds for a study that will fail to demonstrate any potential for vapor accumulation or intrusion from the site contaminants.

Based upon the available information discussed in this memorandum, vapor intrusion exposures in this building do not present a potentially significant threat to human health. The building has signs posted to advise that there is a potential for vapor intrusion and provides the directions by which the potential exposure can be avoided. The Real Property Master Plan will be updated to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions, and/or tenants are changed.

Therefore, the protectiveness as defined in the Record of Decision for the 354 Area Solvent Detections (Operable Unit 005) is still effective and should not be considered deferred based on the potential for vapor intrusion.

6.0 References

Burns & McDonnell 2003 *Draft Final Remedial Investigation Report 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas* Volumes 1 & 2

Burns & McDonnell 2005 *Soil-Gas Investigation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas*

EPA 1989 *Risk Assessment Guidance for Superfund Volume 1 Human Health Manual Part A (RAGS)* EPA/540/1-89/002

EPA 1997 *Health Effects Assessment Summary Tables Annual FY-1997 Office of Emergency and Remedial Response* OERR9200.6-303(91-1)

EPA *Integrated Risk Information System* PCE Evaluation dated February 10, 2012

Malcolm-Pirnie/Burns & McDonnell 2005 *Pilot Study Report Pilot Study for Soil Remediation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas*

U.S. Army Corps of Engineers 2003a *Quality Control Summary Report Indoor Air Sampling Area 354 Fort Riley, Kansas*

U.S. Army Corps of Engineers 2003b *Quality Control Summary Report Indoor Air Sampling 354 Area Solvent Detections Fort Riley, Kansas*

7.0 Appendix

Table 2-2
Soil-Gas Results
(Units of ug/m^3)
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/m^3	TCE ug/m^3	PCE ug/m^3	CCl$_4$ ug/m^3	Comments
B354-SG367a / S22	10 ft	2,000 U	2,000 U	236,000	2,000 U	Reanalysis
B354-SG367a / S03	15 ft	4,000 U	4,000 U	145,000	4,000 U	
B354-SG367a / S04	20 ft	4,000 U	4,000 U	6,200	4,000 U	
B354-SG367a / S05	30 ft	2,000 U	2,000 U	4,000	2,000 U	
B354-SG367a / S06	40 ft	2,000 U	2,000 U	5,400	2,000 U	
B354-SG367a / S07	50 ft	2,000 U	2,000 U	2,500	2,000 U	
B354-SG367b / S03	15 ft	2,000 U	2,000 U	1,900 J	2,000 U	
B354-SG367b / S06	40 ft	2,000 U	2,000 U	6,100	2,000 U	
B354-SG367c / S03	15 ft	2,000 U	2,000 U	4,000	2,000 U	
B354-SG367c / S05	30 ft	2,600	2,000 U	15,000	2,000 U	
B354-SG367c / S06	40 ft	1,500 J	2,000 U	8,000	2,000 U	
B354-SG367c / S07	50 ft	2,300	2,000 U	11,000	2,000 U	
B354-SG368a / S01	5 ft	2,000 U	2,000 U	1,500 J	2,000 U	
B354-SG368b / S02	10 ft	2,000 U	2,000 U	2,700	2,000 U	
B354-SG368c / S01	5 ft	2,000 U	2,000 U	2,200	2,000 U	
B354-SG368c / S05	30 ft	2,000 U	1,700 J	3,300	2,000 U	
B354-SG368c / S07	50 ft	2,000 U	2,000 U	2,400	2,000 U	
B354-SG415b / S07	50 ft	2,000 U	2,000 U	2,000 U	1,700 J	

Notes:

1. Detections are shaded and highlighted.

CCl$_4$ = Carbon Tetrachloride
DCE = cis-1,2-Dichloroethene
PCE = Tetrachloroethene
TCE = Trichloroethene
J = Estimated value
U = Not detected above reporting limit
NS = Not Sampled
ft = feet
bgs = below ground surface
ug/m^3 = micrograms per cubic meter (1,000 liters)

Table 7-11
Noncarcinogenic Toxicity Information for Chemicals of Potential Concern
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Parameter	Oral RfD (mg/kg/day)	Source	Toxic Effect of Concern	Inhalation RfD^1 (mg/kg/day)	Source	Toxic Effect of Concern
PAHs						
Acenaphthylene						
Benzo(a)anthracene						
Benzo(a)pyrene						
Benzo(b)fluoranthene						
Benzo(g,h,i)perylene						
Benzo(k)fluoranthene						
Chrysene						
Dibenz(a,h)anthracene						
Fluoranthene	4E-02	IRIS	Nephropathy, increased liver weights, hematological alterations, and clinical effects			
Indeno(1,2,3-cd)pyrene						
Naphthalene	2E-02	IRIS	Decreased mean terminal body weight in males	9E-04	IRIS	Nasal effects: hyperplasia and metaplasia in olfactory and respiratory epithelium
Phenanthrene						
Pyrene	3E-02	IRIS	Renal tubular pathology, decreased kidney weights			
Volatiles						
1,1,2-Trichloroethane	4E-03	IRIS	Clinical serum chemistry			
Acetone	1E-01	IRIS	Increased liver/kidney weights, nephrotoxicity			
Benzene	4E-03	IRIS	Decreased lymphocyte count	9E-03	IRIS	Decreased lymphocyte count
Carbon disulfide	1E-01	IRIS	Fetal toxicity/malformations	2E-01	IRIS	Peripheral nervous system dysfunction
Carbon tetrachloride	7E-04	IRIS	Liver lesions	6E-04	STSC, a	Liver lesions
Chloroform	1E-02	IRIS	Moderate/marked fatty cyst formation in the liver			
cis-1,2-Dichloroethene	1E-02	HEAST	Decreased hematocrit/hemoglobin			
Ethylbenzene	1E-01	IRIS	Liver and kidney toxicity	3E-01	IRIS	Developmental toxicity
Tetrachloroethene	1E-02	IRIS	Hepatotoxicity in mice, weight gain in rats	2E-01	STSC	Renal tubular cell karyomegaly
Toluene	2E-01	IRIS	Changes in liver and kidney weights	1E-01	IRIS	Neurological effects and deneration of nasal epithelium
trans-1,2-Dichloroethene	2E-02	IRIS	Increased serum alkaline phosphates in male mice			
Trichloroethene	3E-04	STSC	Critical effects in the liver, kidney, and developing fetus	1E-02	STSC	Critical effects in the central nervous system, liver, and endocrine system
Xylenes, total	2E-01	IRIS	Decreased body weight, and increased mortality in males	3E-02	IRIS	Impaired motor coordination
Vinyl chloride	3E-03	IRIS	Liver cell polymorphism	3E-02	IRIS	Liver cell polymorphism

Table 7-11 (continued)
Noncarcinogenic Toxicity Information for Chemicals of Potential Concern
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Notes:

[1] - RfC (mg/m^3) values are converted to RfD (mg/kg/day) values using the equation provided in the preface of HEAST.
IRIS - Integrated Risk Information System (USEPA, 2003)
HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)
KDHE - Risk-Based Standards for Kansas (KDHE, 2001)
STSC - Superfund Technical Support Center (USEPA, 2002)
COPCs - Chemicals of Potential Concern
a - STSC provided a subchronic inhalation RfC for carbon tetrachloride, which was adjusted by a factor of 10 to derive a chronic RfC.
For dermal exposure, current guidance recommends that oral RfDs be adjusted to reflect gastrointestinal absorption efficiency only when the absorption efficiency is less than 50 percent (USEPA, 2001). Absorption efficiencies for the COPCs are greater than 50 percent; thus dermal RfDs represent unadjusted oral RfDs.
Blanks indicate that information is not available.
PAH - Polycyclic Aromatic Hydrocarbon
RfD - Reference Dose
RfC - Reference Concentration
mg - milligrams
kg - kilograms
m^3 - cubic meters
mg/kg/day - milligrams per kilogram per day
mg/m^3 - milligrams per cubic meter

Table 7-12
USEPA Carcinogen Classification*
354 Area Solvent Detections RI Report
Fort Riley, Kansas

CARCINOGEN CATEGORIES

A	Human carcinogen
B	Probable human carcinogen
C	Possible human carcinogen
D	Not classifiable
E	Evidence of noncarcinogenicity

WEIGHT-OF-EVIDENCE CLASSIFICATION MATRIX

	Animal Evidence				
Human Evidence	Sufficient	Limited	Inadequate	No Data	No Evidence
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Inadequate	B2	C	D	D	D
No Data	B2	C	D	D	E
No Evidence	B2	D	D	D	E

Notes: The B category is subdivided into B1 and B2, with the strength of any available human data being the deciding factor.
USEPA = United States Environmental Protection Agency

* FR, 1986

Table 7-13
Carcinogenic Toxicity Information
354 Area Solvent Detection RI Report
Fort Riley, Kansas

Parameter	Weight-of-Evidence Classification[1]	Oral Slope Factor 1/(mg/kg/day)	Source	Inhalation Slope Factor[2] 1/(mg/kg/day)	Source	Site of Tumor
PAHs						
Acenaphthylene	D					
Benzo(a)anthracene	B2	7.3E-01	PAH			
Benzo(a)pyrene	B2	7.3E+00	IRIS	3.1E+00	STSC	Portal-of-entry
Benzo(b)fluoranthene	B2	7.3E-01	PAH			
Benzo(g,h,i)perylene	D					
Benzo(k)fluoranthene	B2	7.3E-02	PAH			
Chrysene	B2	7.3E-03	PAH			
Dibenz(a,h)anthracene	B2	7.3E+00	PAH			
Fluoranthene	D					
Indeno(1,2,3-cd)pyrene	B2	7.3E-01	PAH			
Naphthalene	C					
Phenanthrene	D					
Pyrene	D					
Volatiles						
1,1,2-Trichloroethane	C	5.7E-02	IRIS	5.6E-02	IRIS	Liver
Acetone	D					
Benzene	A	5.5E-02	IRIS	2.7E-02	IRIS	Blood/bone marrow
Carbon disulfide						
Carbon tetrachloride	B2	1.3E-01	IRIS	5.3E-02	IRIS	Liver
Chloroform	B2	NAp		8.1E-02	IRIS	Liver
cis-1,2-Dichloroethene	D					
Ethylbenzene	D					
Tetrachloroethene		5.2E-02	STSC	1.1E-02	STSC	Liver
Toluene	D					
trans-1,2-Dichloroethene						
Trichloroethene		4.0E-01	STSC	4.0E-01	STSC	
Xylenes, total	D					
Vinyl chloride	A	7.5E-01	IRIS	1.5E-02	IRIS	Liver

Notes:

[1] - Weight of evidence classifications obtained from IRIS.

[2] - Unit risk [1/(mg/m^3)] values are converted to slope factors [1/(mg/kg/day)] values using the equation provided in the preface of HEAST.

IRIS - Integrated Risk Information System (USEPA, 2003)

STSC - Superfund Technical Support Center (USEPA, 2002)

HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)

PAH - Slope factor for benzo(a)pyrene adjusted as recommended in Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons (USEPA, 1993).

NAp - Mechanistic data indicates that carcinogenicity of chloroform is an effect of noncancer cytotoxicity; thus, the noncancer RfD is considered protective of the cancer endpoint (USEPA, 2002).

For dermal exposure, current guidance recommends that oral slope factors be adjusted to reflect gastrointestinal absorption efficiency only when the absorption efficiency is less than 50 percent (USEPA, 2001). Absorption efficiencies for the COPCs are greater than 50 percent; thus, dermal slope factors represent unadjusted oral slope factors.

Blanks indicate that information is not available.

mg/m^3 - milligrams per cubic meter

mg/kg/day - milligrams per kilogram per day

APPENDIX 7C – VAPOR MODELING

Concentrations of chemical vapors in indoor and outdoor air were not directly measured during the Remedial Investigation (RI) at the 354 Area Solvent Detections site (Site). Since vapor concentrations are not typically measured at environmental sites, numerous models have been developed to estimate chemical vapor concentrations in air. The available vapor models range in sophistication from complex computer codes to simple conservative algorithms. This appendix describes the methods used to model the migration of chemical vapors from soil, soil gas, and groundwater and estimate vapor concentrations in indoor and outdoor air.

7C.1 METHODOLOGY OVERVIEW

Chemical vapor migration from soil or groundwater to an indoor or outdoor environment consists of three steps: chemical partitioning from soil or groundwater to soil gas, migration of chemical vapors through the soil column and subsequent emission to ambient air, and mixing of chemical vapors within the ambient environment. For soil and groundwater, vapor concentrations were estimated by applying chemical-specific volatilization factors (VFs) to chemical concentrations in soil and groundwater. VFs represent media transfer factors that account for all three steps of the vapor migration process. Chemical-specific VFs are calculated for each medium (soil or groundwater) and for each ambient environment (indoor or outdoor air). The chemical partitioning step is not required when evaluating soil gas; therefore, vapor migration from soil gas to ambient air was modeled using an emission rate/ambient air mixing equation. Rather than calculating VFs, the emission rate/ambient air mixing equation uses the measured chemical concentration in soil gas to predict chemical vapor concentrations in air.

Vapor migration is dependent on both chemical characteristics and soil physical properties. The chemical properties influencing vapor transport include the Henry's law constant (H), organic carbon-water partitioning coefficient (K_{oc}), diffusivity in air (D_i), and diffusivity in water (D_w). Values for each of these properties were obtained from United States Environmental Protection Agency's (USEPA's) *Soil Screening Guidance: Technical Background Document* (USEPA, 1996) for all of the chemicals of potential concern (COPCs).

The soil parameters used in this evaluation represent site-specific measurements obtained from soil samples collected during monitoring well installation. Table 2-3 in the *RI Report* presents the measured soil geotechnical and total organic carbon (TOC) data. Given the large size of the Site, it was not appropriate to average all of the measurements available for each parameter. Rather, bulk density and TOC values were obtained from sample locations closest to the source of contamination in each area of the Site. For the Building 367 Area, soil parameters represented the average of measurements for locations B354-99-08 and B354-01-27, the average of measurements from B354-99-09 was used for the Building 354/332/DPW Area, and the average of measurements from B354-01-26 was used for the Building 430 Area.

Site-specific measures of total porosity ranged from approximately 35 – 41 percent. These values are likely unrealistically high; therefore, a value of 25 percent (as determined by the USGS for Kansas River alluvial deposits [Meyer, 2002]) will be used. Site-specific data were not available for air-filled porosity or water-filled porosity. Given the high degree of variability that would be expected in such data, single point-in-time measurements would likely be considered inappropriate for use in the risk assessment.

Water-filled porosity was calculated using an equation obtained from USEPA's *Soil Screening Guidance: User's Guide* (USEPA, 1996a). The infiltration rate variables were obtained from Table 6 of *Soil Screening Guidance: Technical Background Document* (USEPA, 1996) and represent the alternating sandstone/limestone/shale hydrogeological setting. The variable values for Ks and b were obtained from USEPA's *Soil Screening Guidance: User's Guide*. Selection of the Ks and b variables is based on soil texture, which was determined to most closely resemble a silty loam in the Building 367 and 354/332/DPW Areas and a silty clay in the Building 430 Area. Soils in the Building 367 and 354/332/DPW Areas were originally described as silt, but variable values are not available in the aforementioned guidance documents for a silty soil. Therefore, it was assumed that the classification of a silty soil would best be represented by the values of a silty loam soil. For capillary fringe soils, the relative percent contributions were obtained from American Society of Testing Materials' ASTM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, resulting in water-filled porosity estimates equaling 90 percent of the total porosity and air-filled porosity estimates equaling 10 percent of the total porosity.

Other variables impacting the vapor modeling calculations include depth to groundwater or soil source areas, building characteristics (indoor air estimates), source width parallel to groundwater flow (outdoor air estimates), and wind speed (outdoor air estimates). In general, depth to groundwater was based on average measurements from the monitoring wells included in the groundwater data sets for each area. Depth to soil source areas was based on the average depth at which the highest chemical concentrations were detected in a given area of the Site. Source width in groundwater was based on the widest north-south measurement of the soil source area in the Building 367 Area and on the measured distance between monitoring wells MW95-06 and TSO292-02 in the Building 354/332/DPW Area. Outdoor air was not evaluated in the Building 430 Area. The wind speed was based on Fort Riley measurements (see Section 2.2 of the RI Report), and building characteristics represented default values.

The volatilization factors described in Sections 7C.2 – 7C.4 were subsequently combined with chemical concentrations in soil or groundwater to derive vapor concentrations in air. These vapor concentrations in air are presented in Tables 7-27 through 7-31 of the *RI Report*.

7C.2 VOLATILIZATION FACTORS FROM SOIL

Vapor migration from soil to indoor and outdoor air was evaluated in both the Building 367 Area and the Building 354/332/DPW Area. Volatile organic compounds (VOCs) were not detected in soil samples from the Building 430 Area. The equations and variables used to calculate the VFs from soil are described in the following paragraphs and provided on Tables 7C-2 through 7C-11.

The equation used to calculate the VF from soil to indoor air was obtained from *Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites* (ASTM, 1995) and is based on the indoor vapor model developed by Johnson and Ettinger (1991). This equation takes into account chemical partitioning from soil to soil gas; vapor migration through vadose zone soil, cracks in the building foundation, and into a building; and building characteristics such as foundation integrity, room volume, and the number of air exchanges per day. The soil parameters represent site-specific values (see Section 7C.1), and most of the building characteristics used in this evaluation represent conservative default values, as noted on Tables 7C-2 and 7C-3. The areal fraction of cracks in the building foundation was set at 0.056 percent based on a study by Sager (1997) of 218 homes in the United States. The Johnson and Ettinger model relies on a series of effective diffusion coefficient calculations to accoumt for varying subsurface conditions as chemical vapors migrate from the source area into a building. Separate diffusion coefficients are calculated for vadose zone soil and building foundation cracks. Given the lack of information regarding soil porosity in foundation cracks, the porosity estimates used for soil were also used for foundation cracks (ASTM, 1995). The effective diffusion coefficients for soil and foundation cracks are presented on Tables 7C-4 through 7C-7.

The equation for calculating the VF from soil to outdoor air was obtained from USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002) and combines an estimate of the chemical flux from soil with a simulation of contaminant dispersion in ambient air. The estimate of chemical flux from soil is based on a commonly used partitioning equation, and the simulation of contaminant dispersion in ambient air is represented by the Q/C term. The chemical flux component of the equation is based on the site-specific soil properties and chemical-specific physical properties described in Section 7C.1. The Q/C term reflects the results of air dispersion modeling conducted by USEPA using varying contaminant source sizes and meteorological conditions. The Q/C value was calculated using equation D-1 from USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002). Constants used to calculate the Q/C value represented Zone 5, Lincoln, Nebraska. The equations and variables are presented on Tables 7C-8 and 7C-9. This VF equation is based on the assumption that the source of contamination in soil is at the surface, which is likely true for the excavation scenario in the Building 367 Area. However, the soil source in the Building 354/332/DPW Area is approximately 19 feet below ground surface (bgs), thus using this VF equation likely results in an overestimation of outdoor vapor concentrations in that area. The VF calculations from soil to outdoor air are presented on Tables 7C-10 and 7C-11.

7C.3 VOLATILIZATION FACTORS FROM GROUNDWATER

Vapor migration from groundwater to indoor air was evaluated in all three areas of the Site. Vapor migration from groundwater to outdoor air was evaluated in the Building 367 Area and the Building 354/332/DPW Area. As mentioned in Section 7C.1, outdoor air was not evaluated in the Building 430 Area. The equations and variables used to calculate the VFs from groundwater are described in the following paragraphs and provided on Tables 7C-12 through 7C-24.

Similar to the VF from soil equation, the equation used to calculate the VF from groundwater to indoor air was obtained from the *Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites* (ASTM, 1995) and is based on the indoor vapor model developed by Johnson and Ettinger (1991). This equation takes into account chemical partitioning from groundwater to soil gas; vapor migration through vadose zone soil, cracks in the building foundation, and into a building; and building characteristics such as foundation integrity, room volume, and the number of air exchanges per day. With the exception of depth to groundwater (see Section 7C.1), the soil parameters and building characteristics used in the VF from groundwater calculations are the same as those used in the VF from soil calculations, as noted on Tables 7C-12 through 7C-14. The VF from groundwater contains the same effective diffusion coefficient for building foundation cracks as was used in the soil calculations, and it also includes an effective diffusion coefficient from groundwater to the soil surface. The effective diffusion coefficient from groundwater to the soil surface combines the thickness and effective diffusion coefficient for the vadose zone soil with the thickness and effective diffusion coefficient of the capillary fringe zone. The effective diffusion coefficients for capillary fringe soil were calculated using the 90 percent water-/10 percent air-filled porosity estimates described in Section 7C.1. For the Building 367 and Building 354/332/DPW Areas, the effective diffusion coefficients for soil and foundation cracks are the same as those used for the soil calculations, and the effective diffusion coefficients from groundwater to the soil surface are presented on Tables 7C-13 through 7C-16. For the Building 430 Area, all of the effective diffusion coefficients required to calculate the VF from groundwater to outdoor air are provided in Tables 7C-17 through 7C-20.

The VF from groundwater to outdoor air was calculated using an equation from the *Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites* (ASTM, 1995) that represents a combination of the effective diffusion coefficients for capillary fringe and vadose zone soils and a traditional box model. The effective diffusion coefficients account for the migration of chemical vapors from groundwater to the soil surface, while the box model estimates chemical dispersion in outdoor air. Chemical partitioning from groundwater to soil gas is accounted for through the application of the Henry's Law constant. The effective diffusion coefficients for capillary fringe and vadose zone soils are the same as those used in the indoor air calculations. The wind speed used in this evaluation was based on Fort Riley measurements (see Section 2.2 of the RI Report), and the mixing zone height was based on the standard assumed breathing-zone height of two meters, as noted on Tables 7C-21 and 7C-22.

7C.4 ESTIMATION OF VAPOR CONCENTRATIONS FROM SOIL GAS

The analytical data from and physical characteristics of the Building 430 Area are such that modeling vapor concentrations from soil or groundwater was either impractical or likely to be unreliable. VOCs were not detected in soil samples from the Building 430 Area. Groundwater in this portion of the Site is approximately 58 feet bgs and the detected chemical concentrations were very low. As part of determining placement locations for monitoring wells, soil gas screening was conducted around Building 430 and into the nearby residential neighborhood. The chemical concentrations detected in shallow soil gas samples (nine feet bgs) were higher than those that would be predicted by modeling vapor migration from groundwater; therefore, it was determined that soil gas was the most appropriate medium for estimating indoor vapor concentrations in the Building 430 Area.

Since the analytical data used in the vapor modeling represented vapor-phase concentrations, estimating chemical partitioning was not required. Rather, the chemical concentrations in soil gas were used in a combined emission rate/indoor air dispersion equation that was obtained from *Risk and Decision Making at Petroleum-Impacted Sites* from the University of California Extension, Programs in Environmental Management (1997). This combined emission rate and dispersion equation takes into account the vapor diffusion through soil to the building, vapor flux into a room, volume of the room, and the number of air exchanges per day. The emission rate portion of the equation is based on Fick's Law of diffusion and incorporates effective diffusion coefficients that are calculated following the definition developed by Millington and Quirk (1961). The dispersion portion of the equation is based on the same building characteristics used in the VF calculations from soil and groundwater to indoor air. The equation and variables for calculating indoor vapor concentrations for the Building 430 Area are presented on Table 7C-25.

It should be noted that all of the volatilization equations used in this risk assessment incorporate several conservative assumptions. These calculations ignore biodegradation, removal by leaching, and the adsorption of vapor to soil. They also assume no depletion of the source over time to reduce the emission rate. These fundamental assumptions likely result in a highly conservative estimate of chemical vapor concentrations in indoor and outdoor air.

7C.5 REFERENCES

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Table 7C-1
Calculation of Water-Filled Porosity Values*
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Equation:

$$O_w\ (L/L) = O_t \times \left(\frac{I}{K_s}\right)^{\frac{1}{2b+3}}$$

Where:

Ow = Water-filled porosity (liters per liter [L/L])
Ot = Total soil porosity (L/L) (See Text)
I = Infiltration rate (meter per year [m/yr])
Ks = Saturated hydraulic conductivity (m/yr)
b = Soil-specific exponential parameter (unitless)

Variable Values:

Location	Ot (L/L)	I (m/yr)	Ks (m/yr)	b (unitless)	Ow (L/L)
Building 367 Area	0.25	0.14	120	5.3	0.152
Building 354/332/DPW Area	0.25	0.14	120	5.3	0.152
Building 430 Area	0.25	0.14	8	10.4	0.211

Notes:

Infiltration rates obtained from Table 6 of "Soil Screening Guidance: Technical Background Document" (USEPA, 1996) and represent alternating sandstone/limestone/shale.

Variable values for Ks and b were obtained from "Soil Screening Guidance: User's Guide" (USEPA, 1996a) and represent silty loam in the Building 367 and Building 354/332/DPW Areas and silty clay in the Building 430 Area.

*USEPA, 1996

Table 7C-4
Effective Diffusion Coefficient in Soil
Building 367 Area
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Equation:

$$D_i^{eff}\left[\frac{cm^2}{s}\right] = D^i\,\frac{\Theta_{as}^{3.33}}{\Theta_T^2} + \left(D^w \times \frac{1}{H'} \times \frac{\Theta_{ws}^{3.33}}{\Theta_T^2}\right)$$

Where:

Deffs = Effective diffusion coefficient in soil based on vapor-phase concentration (cm²/s)
Di = Diffusion coefficient in air (cm²/s)
Oas = Air-filled porosity in vadose zone soils (L/L)
Dw = Diffusion coefficient in water (cm²/s)
Ows = Water-filled porosity in vadose zone soils (L/L)
Ot = Total soil porosity (L/L)
H' = Henry's law constant (unitless)

Variable Values:

Deffs = Calculated
Di = Chemical-specific (USEPA, 1996)
Oas = 0.10 L/L (site-specific) (Ot - Ows)
Dw = Chemical-specific (USEPA, 1996)
Ows = 0.152 L/L (site-specific) (See Table 7C-1)
Ot = 0.25 L/L (See Text)
H' = Chemical-specific (USEPA, 1996)

Chemical	Di (cm²/s)	Dw (cm²/s)	H' (unitless)	Deffs (cm²/s)
1,1,2-Trichlorethane	7.80E-02	8.80E-06	3.74E-02	5.50E-04
Acetone	1.24E-01	1.14E-05	1.59E-03	1.08E-03
Carbon disulfide	1.04E-01	1.00E-05	1.24E+00	7.24E-04
Carbon tetrachloride	7.80E-02	8.80E-06	1.25E+00	5.43E-04
Chloroform	1.04E-01	1.00E-05	1.50E-01	7.26E-04
cis-1,2-Dichloroethene	7.36E-02	1.13E-05	1.67E-01	5.14E-04
Tetrachloroethene	7.20E-02	8.20E-06	7.54E-01	5.02E-04
trans-1,2-Dichloroethene	7.07E-02	1.19E-05	3.85E-01	4.93E-04
Trichloroethene	7.90E-02	9.10E-06	4.22E-01	5.51E-04
m,p-Xylene	7.35E-02	8.12E-06	3.08E-01	5.12E-04
Vinyl chloride	1.06E-01	1.23E-06	1.11E+00	7.38E-04

*ASTM, 1995

Table 7C-6
Effective Diffusion Coefficient Through Foundation Cracks*
Building 367 Area
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Equation:

$$D^{eff}_{crack}\left[\frac{cm^2}{s}\right] = D^i\,\frac{\Theta^{3.33}_{acrack}}{\Theta^2_T} + \left(D^w \times \frac{1}{H'} \times \frac{\Theta^{3.33}_{wcrack}}{\Theta^2_T}\right)$$

Where:

Deffcrack = Effective diffusion coefficient through foundation cracks (squared centimeters per second [cm²/s])
Di = Diffusion coefficient in air (cm²/s)
Oacrack = Air-filled porosity in foundation crack (liters per liter [L/L])
Dw = Diffusion coefficient in water (cm²/s)
Owcrack = Water-filled porosity in foundation crack (L/L)
Ot = Total soil porosity (L/L)
H' = Henry's law constant (unitless)

Variable Values:

Deffcrack = Calculated
Di = Chemical-specific (USEPA, 1996)
Oacrack = 0.098 L/L (site-specific) (Ot -Owcrack)
Dw = Chemical-specific (USEPA, 1996)
Owcrack = 0.152 L/L (site-specific) (See Table 7C-1)
Ot = 0.25 L/L (See Text)
H' = Chemical-specific (USEPA, 1996)

Chemical	Di (cm²/s)	Dw (cm²/s)	H' (unitless)	Deffcrack (cm²/s)
1,1,2-Trichlorethane	7.80E-02	8.80E-06	3.74E-02	5.50E-04
Acetone	1.24E-01	1.14E-05	1.59E-03	1.08E-03
Carbon disulfide	1.04E-01	1.00E-05	1.24E+00	7.24E-04
Carbon tetrachloride	7.80E-02	8.80E-06	1.25E+00	5.43E-04
Chloroform	1.04E-01	1.00E-05	1.50E-01	7.26E-04
cis-1,2-Dichloroethene	7.36E-02	1.13E-05	1.67E-01	5.14E-04
Tetrachloroethene	7.20E-02	8.20E-06	7.54E-01	5.02E-04
trans-1,2-Dichloroethene	7.07E-02	1.19E-05	3.85E-01	4.93E-04
Trichloroethene	7.90E-02	9.10E-06	4.22E-01	5.51E-04
m,p-Xylene	7.35E-02	8.12E-06	3.08E-01	5.12E-04
Vinyl chloride	1.06E-01	1.23E-06	1.11E+00	7.38E-04

*ASTM, 1995

Table 7C-12
Volatilization Factor to Indoor Air from Groundwater *
Building 367 Area
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Equation:

$$VF_{wesp}\left[L/m^3\right]=\frac{H'\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\times L_b}\right]}{1+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\times L_b}\right]+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)n}\right]}\times 10^3\,\frac{L}{m^3}$$

Where:

VFwesp = Volitilization factor for groundwater to enclosed-space vapors (Liters per cubic meter [L/m³])
H' = Henry's law constant (unitless)
Deffws = Effective diffusion coefficient between groundwater and soil surface (squared centimeters per second [cm²/s])
Lgw = Depth to groundwater (centimeters [cm]), where Lgw = hcap + hv
hcap = Thickness of capillary fringe (cm)
hv = Thickness of vadose zone (cm)
ER = Enclosed-space air exchange rate (inverse seconds [s⁻¹])
Lb = Enclosed-space volume/infiltration area ratio (cm)
Deffcrack = Effective diffusion coefficient through foundation cracks (cm²/s)
Lcrack = Enclosed-space foundation or wall thickness (cm)
n = Areal fraction of cracks in foundations/walls (squared centimeters per squared centimeter [cm²/cm²])

Variables:

VFwesp = Calculated
H' = Chemical-specific (USEPA, 1996)
Deffws = Chemical-specific (See Table 7C-15)
Lgw = 1585 cm (site-specific) (average depth to groundwater in wells B354-99-08 and B354-01-27)
hcap = 5 cm (ASTM, 1995)
hv = 1580 cm (site-specific)
ER = 0.00028 s⁻¹ (assumes 24 air exchanges per day)
Lb = 300 cm (ASTM, 1995) (assumes 10-ft room height)
Deffcrack = Chemical-specific (See Table 7C-6)
Lcrack = 15 cm (ASTM, 1995) (represents 6-inch floor slab)
n = 0.00056 cm²/cm² (Sager, 1997)

Chemical	H' (unitless)	Deffws (cm²/s)	Deffcrack (cm²/s)	VFwesp (L/m³)
1,1,2-Trichlorethane	3.74E-02	5.23E-04	5.50E-04	8.61E-06
Carbon tetrachloride	1.25E+00	4.32E-04	5.43E-04	2.81E-04
Chloroform	1.50E-01	6.32E-04	7.26E-04	4.53E-05
cis-1,2-Dichloroethene	1.67E-01	4.59E-04	5.14E-04	3.58E-05
Tetrachloroethene	7.54E-01	4.05E-04	5.02E-04	1.57E-04
trans-1,2-Dichloroethene	3.85E-01	4.19E-04	4.93E-04	7.89E-05
Trichloroethene	4.22E-01	4.56E-04	5.51E-04	9.64E-05
Vinyl chloride	1.11E+00	5.72E-04	7.38E-04	3.38E-04

*ASTM, 1995

Table 7-14

Summary of Pathways Considered for Human Health Risk Assessment

354 Area Solvent Detections RI Report

Fort Riley, Kansas

Potentially Exposed Populations	Media-Specific Exposure Pathways	Pathway Selected for Risk Characterization	Reason for Selecting or Excluding Pathways
		Building 367 Area	
Current Scenario			
Groundskeeper	Surface Soil	no	- Due to the presence of pavement, groundskeeping is not required in the Building 367 source area.
	Subsurface Soil	no	
	Groundwater	no	
	Soil Gas	no	
Future Scenario			
Groundskeeper	Surface Soil	no	- Due to the presence of pavement, groundskeeping is not required in the Building 367 source area.
	Subsurface Soil	no	
	Groundwater	no	
	Soil Gas	no	
Indoor Worker	Surface Soil	no	- Unpaved surface soil is not present.
	Subsurface Soil		
	Incidental ingestion	no	- Indoor workers are unlikely to directly contact subsurface soil.
	Dermal absorption	no	
	Inhalation of dust	no	
	Inhalation of vapors	yes	- Chemical vapors may migrate to indoor air.
	Groundwater		
	Ingestion	no	- Terrace groundwater is unlikely to be used as a potable water source.
	Dermal absorption	no	
	Inhalation of vapors	yes	- Chemical vapors may migrate to indoor air.
	Soil Gas	no	- Soil gas screening data is generally not considered of sufficient quality for use in risk assessment.
Utility Excavation Worker	Surface Soil	no	- Unpaved surface soil is not present.
	Subsurface Soil		
	Incidental ingestion	yes	- Presence of numerous utility lines on Main Post could necessitate repair, which may cause direct contact with shallow subsurface soil and inhalation of chemical vapors from soil.
	Dermal absorption	yes	
	Inhalation of dust	yes	
	Inhalation of vapors	yes	
	Groundwater		
	Ingestion	no	- Terrace groundwater is unlikely to be used as a potable water source and too deep for contact.
	Dermal absorption	no	
	Inhalation of vapors	yes	- Chemical vapors may migrate to ambient air.

Table 7-14 (continued)
Summary of Pathways Considered for Human Health Risk Assessment
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Potentially Exposed Populations	Media-Specific Exposure Pathways	Pathway Selected for Risk Characterization	Reason for Selecting or Excluding Pathways
Building 367 Area (continued)			
Future Scenario (continued)			
Utility Excavation Worker (continued)	Soil Gas	no	- Soil gas screening data is generally not considered of sufficient quality for use in risk assessment.

Table 7C-15
Effective Diffusion Coefficient Between Groundwater and Soil Surface*
Building 367 Area
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Equation:

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=\frac{\left(h_{cap}+h_v\right)}{\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]}$$

Where:

Deffws = Effective diffusion coefficient between groundwater and soil surface (squared centimeters per second [cm²/s])
hcap = Thickness of capillary fringe (centimeters [cm])
hv = Thickness of vadose zone (cm)
Deffcap = Effective diffusion coefficient through capillary fringe (cm²/s)
Deffs = Effective diffusion coefficient in soil based on vapor-phase concentration (cm²/s)

Variables:

Deffws = Calculated
hcap = 5 cm (ASTM, 1995)
hv = 1580 cm (site-specific)
Deffcap = Chemical-specific (See Table 7C-16)
Deffs = Chemical-specific (See Table 7C-4)

Chemical	Deffcap (cm²/s)	Deffs (cm²/s)	Deffws (cm²/s)
1,1,2-Trichlorethane	3.20E-05	5.50E-04	5.23E-04
Carbon tetrachloride	6.56E-06	5.43E-04	4.32E-04
Chloroform	1.51E-05	7.26E-04	6.32E-04
cis-1,2-Dichloroethene	1.30E-05	5.14E-04	4.59E-04
Tetrachloroethene	6.54E-06	5.02E-04	4.05E-04
trans-1,2-Dichloroethene	8.68E-06	4.93E-04	4.19E-04
Trichloroethene	8.25E-06	5.51E-04	4.56E-04
Vinyl Chloride	7.97E-06	7.38E-04	5.72E-04

*ASTM, 1995

Table 7-44
Summary of Risk Results
354 Area Solvent Detections RI Report
Fort Riley, Kansas

Population	Noncarcinogenic Hazard Quotients	Carcinogenic Risks
Building 367 Area		
Future Indoor Worker		
Inhalation of Vapors Pathway	3E-04	2E-07
Future Indoor Worker Total	**3E-04**	**2E-07**
Future Utility Excavation Worker		
Ingestion Pathway	8E-05	2E-08
Dermal Pathway	1E-07	2E-09
Inhalation of Dust Pathway	5E-10	2E-13
Inhalation of Vapors Pathway	2E-05	2E-08
Future Utility Excavation Worker Total	**1E-04**	**4E-08**
Building 354/332/DPW Compound Area		
Current Indoor Worker		
Ingestion Pathway	2E-05	5E-07
Inhalation of Vapors Pathway	3E-03	2E-08
Current Indoor Worker Total	**3E-03**	**5E-07**
Current Groundskeeper		
Ingestion Pathway	5E-06	1E-07
Dermal Pathway	5E-07	9E-09
Inhalation of Dust Pathway	NAp	1E-12
Inhalation of Vapors Pathway	8E-04	1E-09
Current Groundskeeper Total	**9E-04**	**1E-07**
Building 430 Area		
Current Child Resident		
Ingestion Pathway	2E-04	6E-07
Dermal Pathway	7E-05	2E-07
Inhalation of Dust Pathway	NAp	5E-12
Inhalation of Vapors Pathway	4E-05	1E-10
Current Child Resident Total	**3E-04**	**8E-07**

Note:
NAp - Not applicable

Sample Results for Air Analysis Ft. Riley March 2003

Sample Number	022603-330-01		022603-330-02		022603-335-01		022603-407-01	
	ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3
Vinyl Chloride	< 0.008 R	< 0.021 R	0.34 R	0.88 R	0.013 R	0.034 R	0.008 R	0.021 R
1,1-DCE	< 0.020 R	< 0.081 R	0.031 R	0.12 R	0.044 R	0.18 R	< 0.020 R	< 0.081 R
trans-1,2-DCE	< 0.0080 R	< 0.0032 R	0.041 R	0.16 R	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R
cis-1,2-DCE	0.15 R	0.6 R	18 R	72 R	0.063 R	0.25 R	0.042 R	0.17 R
Carbon Tetrachloride	0.098 R	0.63 R	0.0978 R	0.62 R	0.095 R	0.61 R	0.09 R	0.58 R
TCE	0.12 R	0.66 R	2.4 R	13 R	0.072 R	0.4 R	0.042 R	0.23 R
PCE	1.8 R	12 R	0.54 R	3.7 R	1.2 R	8.3 R	0.29 R	2 R

Table 7A

Sample Number	022603-407-02		022603-367-01		022603-367-02		022603-368-01	
	ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3
Vinyl Chloride	< 0.0080 R	<0.021 R	0.11 R	0.29 R	< 0.0080 R	< 0.021 R	0.78 R	2 R
1,1-DCE	< 0.020 R	< 0.081 R	< 0.020 R	< 0.081 R	0.14 R	0.56 R	0.053 R	0.21 R
trans-1,2-DCE	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R	< 0.016 R	< 0.064 R
cis-1,2-DCE	0.055 R	0.22 R	2.2 R	8.8 R	0.069 R	0.28 R	0.32 R	1.3 R
Carbon Tetrachloride	0.092 R	0.59 R	0.093 R	0.6 R	0.093 R	0.6 R	0.083 R	0.53 R
TCE	1.8 R	10 R	0.77 R	4.3 R	0.25 R	1.4 R	0.29 R	1.6 R
PCE	6.7 R	46 R	1.5 R	10 R	2.6 R	18 R	1.1 R	7.6 R

Table 7B

Sample Results for Air Analysis Ft. Riley March 2003								
Sample Number	022603-368-02		022603-366-01		022603-366-02		022603-366-04	
	Ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3
Vinyl Chloride	0.0091 R	0.024 R	< 0.0080 R	< 0.021 R	0.01 R	0.026 R	0.35 R	0.091 R
1,1-DCE	0.18 R	0.73 R	< 0.020 R	< 0.081 R	< 0.020 R	< 0.081 R	< 0.020 R	< 0.081 R
trans-1,2-DCE	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R	< 0.0080 R	< 0.032 R
cis-1,2-DCE	0.041 R	0.16 R	0.14 R	0.56 R	0.34 R	1.4 R	0.052 R	0.21 R
Carbon Tetrachloride	0.089 R	0.57 R	0.093 R	0.6 R	0.09 R	0.58 R	0.089 R	0.57 R
TCE	0.21 R	1.2 R	0.062 R	0.34 R	0.79 R	4.4 R	0.055 R	0.3 R
PCE	0.32 R	2.2 R	3.1 R	21 R	5.2 R	36 R	2.4 R	17 R

Table 7C

Sample Results for Air Analysis Ft. Riley March 2003					
Sample Number	002603-364-01		0022603-364-02		Risk Levels
					Worker
	ppbv	ug/m^3	ppbv	ug/m^3	ug/m^3
Vinyl Chloride	0.036 R	0.094 R	0.077 R	0.2 R	9
1,1-DCE	< 0.020 R	< 0.081 R	< 0.020 R	< 0.081 R	291
trans-1,2-DCE	0.41 R	1.6 R	< 0.0080 R	< 0.032 R	102
cis-1,2-DCE	37 R	150 R	1 R	4 R	51
Carbon Tetrachloride	0.083 R	0.53 R	0.086 R	0.55 R	3
TCE	4 R	22 R	1.3 R	7.2 R	0.4
PCE	1.3 R	9 R	1.7 R	12 R	14

Table 7D
Shaded results are above industrial risk levels.

Duplicate Results				
	Duplicate			QA
	366-01	366-02	RPD	366-03
Vinyl Chloride	< 0.021	0.026	--	< 0.024
1,1-DCE	< 0.081	< 0.081	--	0.0806
trans-1,2-DCE	< 0.032	< 0.032	--	< 0.038
cis-1,2-DCE	0.56	1.4	150%	< 0.038
Carbon Tetrachloride	0.6	0.58	3.45%	0.166
TCE	0.34	4.4	1190%	< 0.05
PCE	21	36	71.4%	< 0.065

Table 6

Sample Results for Air Analysis Ft. Riley June ~~March~~ 2003

Sample Number	042303-330-01		042303-330-02		042303-335-01		042303-364-01	
	ppbv	Ug/m^3	Ppbv	Ug/m^3	Ppbv	ug/m^3	ppbv	ug/m^3
Vinyl Chloride	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R
1,1-DCE	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R
trans-1,2-DCE	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R
cis-1,2-DCE	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R
Carbon Tetrachloride	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R
TCE	0.069 R	0.38 R	< 0.04 R	< 0.22 R	< 0.04 R	< 0.22 R	1.7 R	9.4 R
PCE	1.8 R	12 R	< 1.1 R	< 7.6 R	< 1.1 R	< 7.6 R	7.5 R	52 R

Table 6A

Sample Results for Air Analysis Ft. Riley June ~~March~~ 2003

Sample Number	042303-364-02		042203-366-01		042203-366-02		042203-366-04	
	ppbv	Ug/m^3	Ppbv	ug/m^3	ppbv	ug/m^3	ppbv	ug/m^3
Vinyl Chloride	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R
1,1-DCE	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R
Trans-1,2-DCE	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R
cis-1,2-DCE	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R
Carbon Tetrachloride	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R
TCE	1.8 R	10 R	0.14 R	0.77 R	< 0.04 R	<0.22 R	0.11 R	0.61 R
PCE	6.6 R	46 R	< 1.1 R	< 7.6 R	< 1.1 R	< 7.6 R	2.1 R	14 R

Table 6B

Sample Results for Air Analysis Ft. Riley ~~March~~ June 2003

Sample Number	042303-367-01		042303-367-02		042203-368-01		042203-368-02	
	Ppbv	ug/m^3	Ppbv	ug/m^3	Ppbv	ug/m^3	ppbv	Ug/m^3
Vinyl Chloride	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R
1,1-DCE	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R	< 50 R	< 200 R
trans-1,2-DCE	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R	< 17 R	< 68 R
cis-1,2-DCE	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R	< 8.8 R	< 35 R
Carbon Tetrachloride	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R
TCE	< 0.04 R	< 0.22 R	0.04 R	0.22 R	< 0.04 R	< 0.22 R	< 0.04 R	< 0.22 R
PCE	2.5 R	17 R	3.9 R	27 R	< 1.1 R	< 7.6 R	< 1.1 R	< 7.6 R

Table 6C

Sample Results for Air Analysis Ft. Riley ~~March~~ June 2003

Sample Number	042203-01				Risk Levels
					Worker
	ppbv	ug/m^3	ppbv	ug/m^3	ug/m^3
Vinyl Chloride	< 0.42 R	< 1.1 R	< 0.42 R	< 1.1 R	9
1,1-DCE	< 50 R	< 200 R	< 50 R	< 200 R	291
trans-1,2-DCE	< 17 R	< 68 R	< 17 R	< 68 R	102
cis-1,2-DCE	< 8.8 R	< 35 R	< 8.8 R	< 35 R	51
Carbon Tetrachloride	< 0.25 R	< 1.6 R	< 0.25 R	< 1.6 R	3
TCE	< 0.04 R	< 0.22 R	0.25 R	1.4 R	0.4
PCE	< 1.1 R	< 7.6 R	< 1.1 R	< 7.6 R	14

Table 6D
Shaded results are above industrial risk levels.

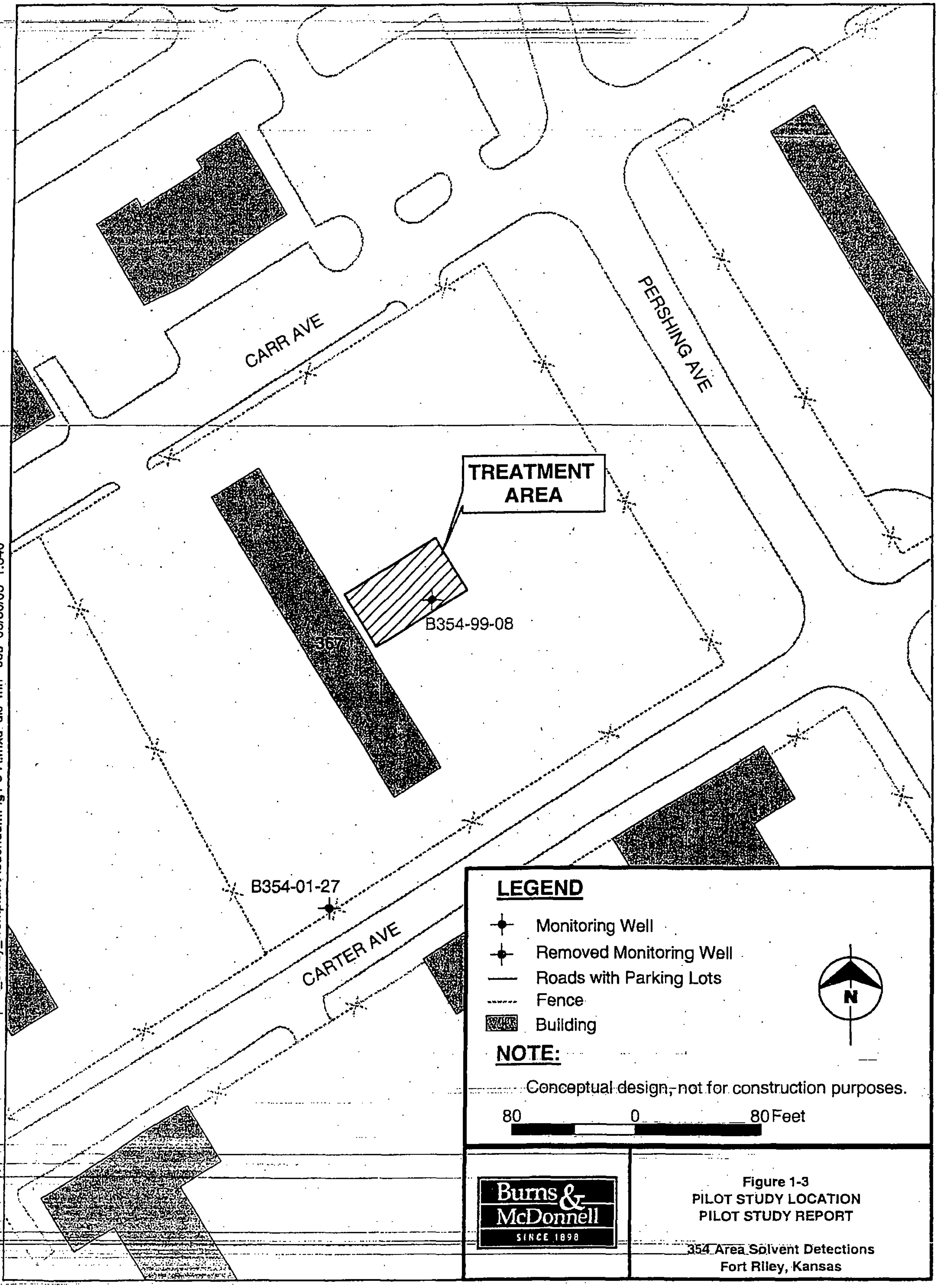


Figure 1-3
PILOT STUDY LOCATION
PILOT STUDY REPORT

354 Area Solvent Detections
Fort Riley, Kansas

U:\armycorp\Projects\b354\ARC\ArcDocs\pilot_study_workplan\AddendumFig1-3-A.mxd dls mh sos 03/30/05 1:840

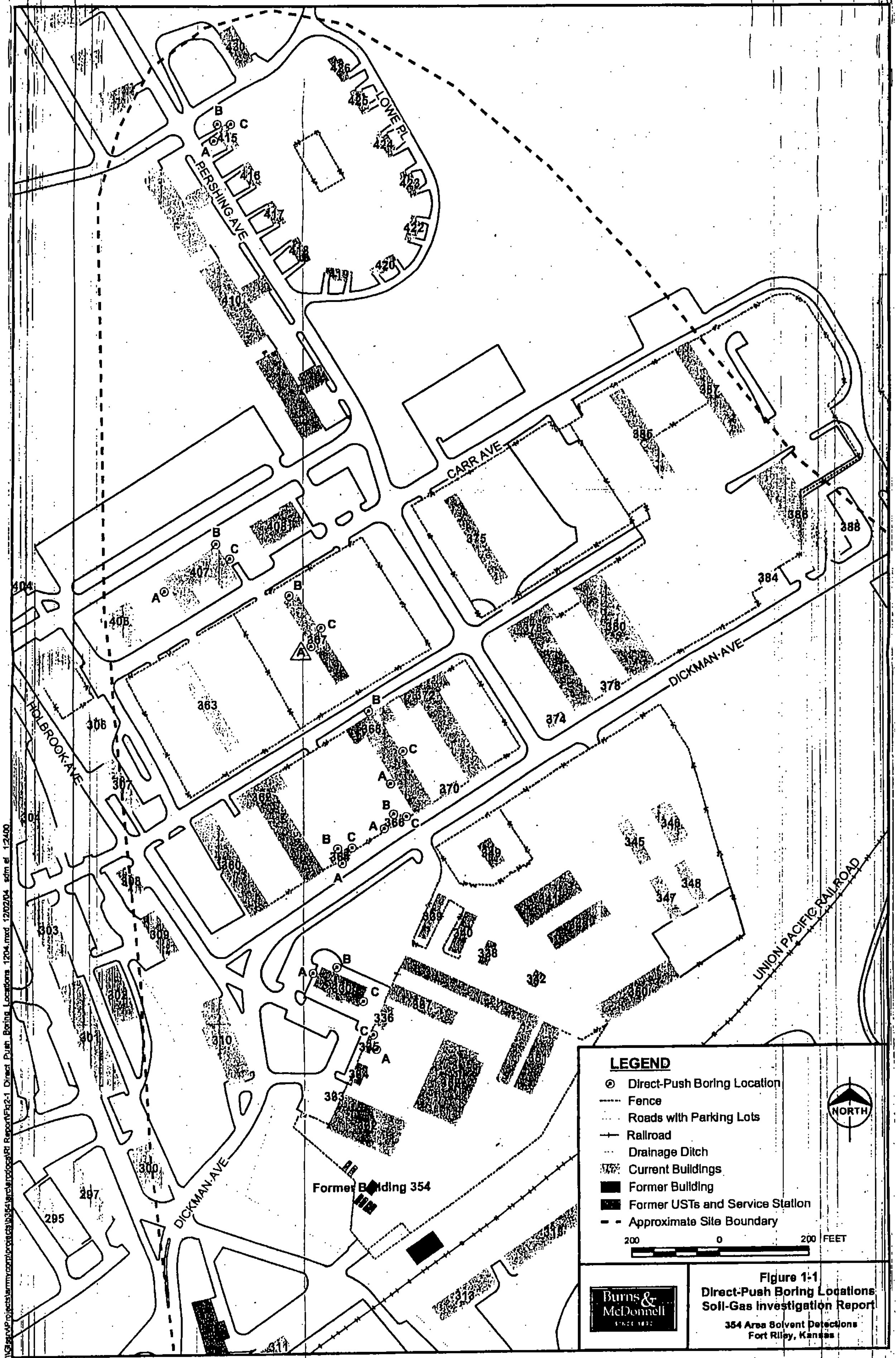


Figure 1-1
Direct-Push Boring Locations
Soil-Gas Investigation Report
354 Area Solvent Detections
Fort Riley, Kansas

\\Gserv\Projects\armycorp\projects\b354\arc\arcdocs\RI Report\Fig2-1 Direct Push Boring Locations 1204.mxd 12/02/04 sdm el 12400

Table 3-2
Confirmation Sampling Results vs Depth - April 2004
Pilot Study Report
354 Area Solvent Detections
Fort Riley, Kansas

PCE RESULTS (in ug/kg)

Sample	Depth (ft)	*Grid Cell 6* *B354-PSB01*	*Grid Cell 5* *B354-PSB02*	*Grid Cell 4* *B354-PSB03*	*Grid Cell 10* *B354-PSB04*	*Grid Cell 16* *B354-PSB05*	*Grid Cell 12* *B354-PSB06*	*Grid Cell 18* *B354-PSB07*	*Grid Cell 20* *B354-PSB08*
SB01	0-1	***475***	***376***	***535***	***342***	***418***	***594***	***2522***	***364***
SB02	1-4	***592***	***387***	***390***	***264***	***405***	***466***	***648***	***331***
SB03	4-7	***478***	***452***	***207***	***352***	***194***	***648***	***84.7***	***425***
SB04	7-10	***597***	***482***	***216***	***22***	***106***	***750***	***119***	***582***
SB05	20-24	***6.11J***	***60.2***	***34.8***	4.91U	***14J***	***11.9J***	***64.9***	***6.88***
SB06	30-34	***158***	***10.4J***	***136***	***416***	***350***	***508***	***2.13***	2.45U
SB07	40-44	***269***	***212***	***7.08J***	***61.4***	***322***	***406***	***26.8***	2.66U

TCE RESULTS (in ug/kg)

Sample	Depth (ft)	*Grid Cell 6* *B354-PSB01*	*Grid Cell 5* *B354-PSB02*	*Grid Cell 4* *B354-PSB03*	*Grid Cell 10* *B354-PSB04*	*Grid Cell 16* *B354-PSB05*	*Grid Cell 12* *B354-PSB06*	*Grid Cell 18* *B354-PSB07*	*Grid Cell 20* *B354-PSB08*
SB01	0-1	***53.2***	***173***	***45.4***	***58.5***	***111***	***144***	***393***	***97***
SB02	1-4	***21.4***	***79.4***	***24.9***	***36.1***	***54.9***	***317***	***285***	***77.7***
SB03	4-7	***25.4***	***22.3***	***4.52J***	***20.9J***	***44.7***	***90.9***	***5.91J***	***47.6***
SB04	7-10	***18.8J***	***8.78J***	***4.99J***	0.88U	***9.9J***	***63.2***	***12.5J***	***68.7***
SB05	20-24	0.706U	***4.84J***	***2.42J***	3.5U	1.22U	1.29U	***11J***	2.01U
SB06	30-34	***14.4***	0.886U	***13.7J***	***45.3***	***34.9***	***63.6***	1.19U	1.74U
SB07	40-44	***16.4***	***56.6***	1.92U	***4.97J***	***24.2***	***46.2***	1.58U	1.89U

CIS-1,2-DCE RESULTS (In ug/kg)

Sample	Depth (ft)	*Grid Cell 6* *B354-PSB01*	*Grid Cell 5* *B354-PSB02*	*Grid Cell 4* *B354-PSB03*	*Grid Cell 10* *B354-PSB04*	*Grid Cell 16* *B354-PSB05*	*Grid Cell 12* *B354-PSB06*	*Grid Cell 18* *B354-PSB07*	*Grid Cell 20* *B354-PSB08*
SB01	0-1	***84.2***	***93.6***	***88.2J***	***89.2***	***112***	***170***	***262***	***140***
SB02	1-4	***51.2J***	***83.1***	***62.3***	***56.2***	***67.2***	***228***	***148***	***127***
SB03	4-7	***53.5***	***46.7J***	***11.2J***	***95.6***	***49.1***	***402***	***25.8J***	***79.1***
SB04	7-10	***42.4J***	***9.96J***	***12.6J***	***8.86J***	***22.3***	***186***	***42.6***	***116***
SB05	20-24	***1.69J***	***54.7***	***30.2***	***12.9***	***43.4***	***38.7***	***135***	***20.5***
SB06	30-34	***104***	***14.2***	***105***	***408***	***258***	***86.2***	***3.32***	1.69U
SB07	40-44	***42.6***	***81.9***	***2.13J***	***44.6***	***128***	***329***	***101***	1.84U

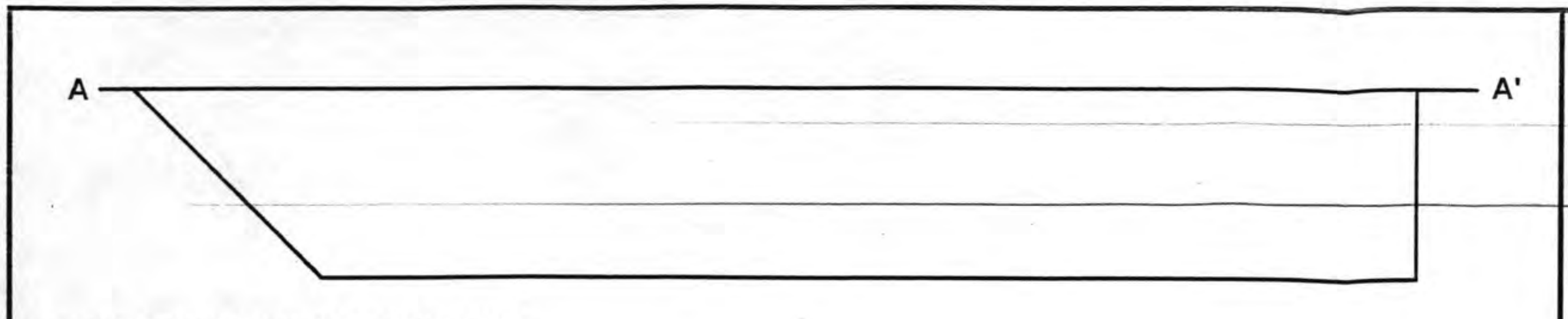
Notes:

J - Estimated between reporting and detection limit.

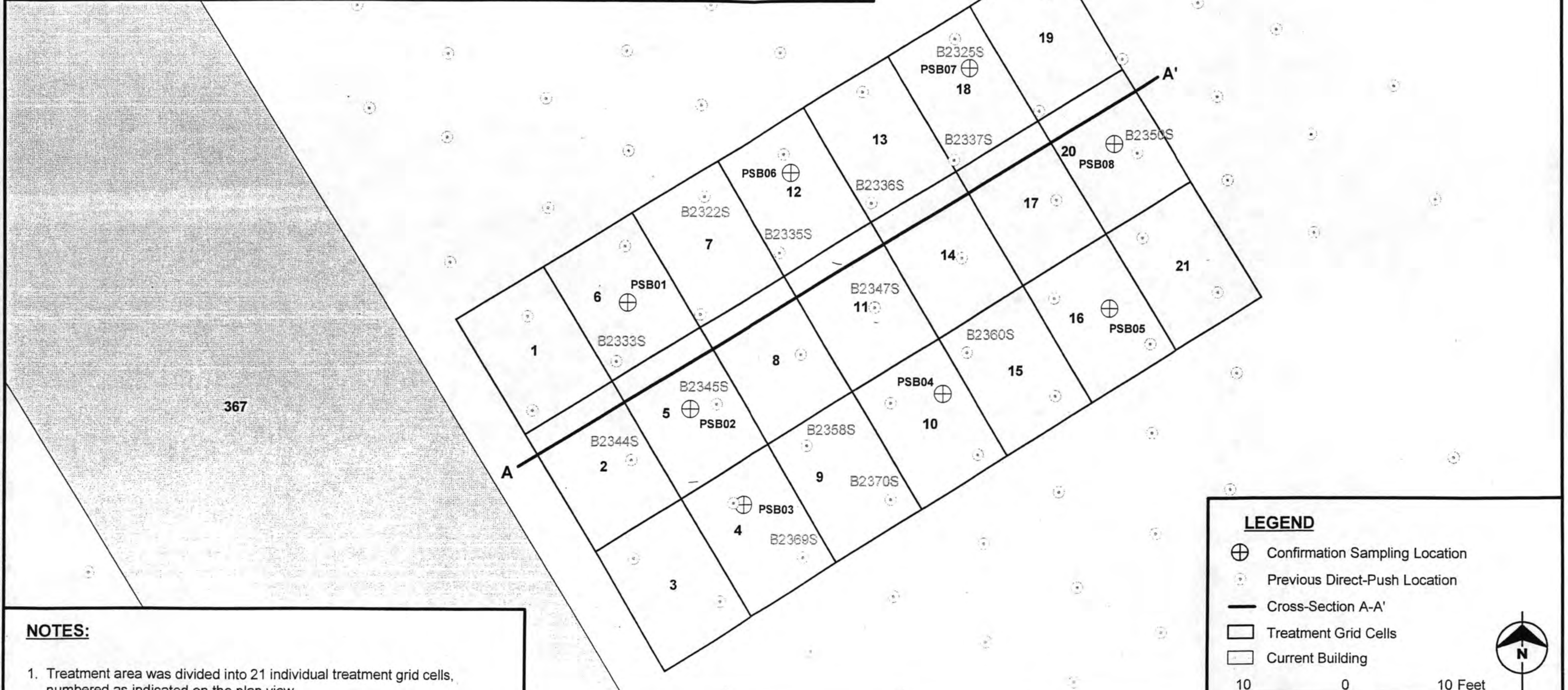
U - Not detected above the detection limit.

Bold and italic indicates a positive detection

Shaded indicates a detection above the KDHE RSK standard for soil-to-groundwater pathway (residential)
(PCE - 180 ug/kg; TCE - 200 ug/kg; and cis-1,2-DCE - 800 ug/kg)



CROSS-SECTION OF TREATMENT AREA



NOTES:

1. Treatment area was divided into 21 individual treatment grid cells, numbered as indicated on the plan view.
2. Cross-section A - A' shows the 1:1 slope at the base of the treated soil volume at its west end, adjacent to Building 367. This slope provided a buffer to protect the building foundation.
3. Only the previous direct-push locations discussed in Section 1 are labeled.

LEGEND

⊕	Confirmation Sampling Location
⊙	Previous Direct-Push Location
—	Cross-Section A-A'
☐	Treatment Grid Cells
▨	Current Building

Burns & McDonnell
SINCE 1898

Figure 2-1
SOIL TREATMENT GRID CELLS
PILOT STUDY REPORT

354 Area Solvent Detections
Fort Riley, Kansas

u:/armycorp/projects/b354/arc/arcdocs/pilot-study_workplan/fig2-1_soil_treatment_grid_cells-B.mxd 06/21/05 rlf el sos 1:120

Technical Memorandum Concentrations

MW & Year	cis-1, 2-DCE	PCE	TCE	Xylenes (Total)	arbon Tetrachlorid	Benzene
354-99-09 4/04	ND	60.0	1.2	ND	1.1	ND
354-99-09 10/04	ND	37.8	0.7	ND	1.6	ND
354-99-09 4/05	ND	27.3	ND	ND	1.9	ND
354-99-09 9/06	ND	75.9	1.1	ND	1.5	ND
354-99-09 4/07	ND	49.0	0.7	ND	1.4	ND
354-99-09 3/08	ND	39.4	ND	ND	1.0	ND
354-99-09 3/09	ND	34.5	ND	ND	1.0	ND
354-99-09 8/11	ND	13.0	ND	ND	ND	ND
354-99-09 4/12	ND	8.1	ND	ND	ND	ND
354-99-27 4/04	ND	88.4	1.1	ND	1.1	ND
354-99-27 10/04	ND	78.8	1.2	ND	1.0	ND
354-99-27 4/05	ND	98.5	1.0	ND	0.9	ND
354-01-27 9/06	ND	97.7	1.0	ND	0.8	ND
354-01-27 4/07	ND	82.9	1.1	ND	1.1	ND
354-01-27 3/08	ND	76.1	1.0	ND	0.8	ND
354-01-27 3/09	ND	22.0J	ND	ND	ND	ND
354-01-27 8/11	ND	28.0	ND	ND	ND	ND
354-01-27 4/12	ND	8.9	ND	ND	ND	ND

All concentrations in ug/L Shaded areas exceed MCL

Risk Screening Table

Site Specific
Indoor Worker Equation Inputs for Air

Variable	Value
TR (target cancer risk) unitless	10E-6
THQ (target hazard quotient) unitless	1
AT_w (averaging time	365
EF_w (exposure frequency) d/yr	30
ED_w (exposure duration) years	1
ET_w (exposure time) hours	1
LT (lifetime) yr	70

Site Specific
Indoor Worker Risk-Based Screening Levels (RSL) for Air

ca = cancer, nc = non-cancer (where nc SL < 100 x ca SL),
ca** (where nc SL <> 10 x ca SL)
max = SL exceeds ceiling limit (see User's Guide), sat = SL exceeds csat

	CAS Number	Inhalation Unit Risk $(ug/m^3)^{-1}$	IUR Ref	Carcinogenic SL TR=1E-06 (ug/m^3)	Non-carcinogenic SL HI=1 (ug/m^3)	Screening Level (ug/m^3)
Tetrachloroethylene	127-18-4	2.60E-07	U	7.86E+04	1.17E+04	1.17E=04 nc

Risk Screening Table

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225C LC


040089


QuickFilter
3
FORT RILEY
FORT RILEY
TOP LOAD
FRAGILE
HANDLE WITH CARE
P OUT


LEAVE DOORS OPEN
DURING OCCUPANCY


WARNING