Pilot Study Report
for the
Dry Cleaning Facility Study Area
Operable Unit (003)
at
Fort Riley, Kansas

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Prepared by

Burns & McDonnell
SINCE 1898

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LIST OF ACRONYMS AND ABBREVIATIONS

AGL	Abandoned High Pressure Gas Line
AOC	Area of Concern
bgs	Below Ground Surface
BMcD	Burns & McDonnell Engineering Company, Inc.
CAS	Continental Analytical Services
CD	Construction Debris
cis-1,2-DCE	cis-1,2-Dichloroethylene
COC	Chain-of-Custody
COPC	Contaminant of Potential Concern
DCF	Dry Cleaning Facilities Study Area and DCFA
DO	Dissolved Oxygen
DPW	Directorate of Public Works
DRMO	Defense Reutilization and Marketing Office
PWE	Directorate of Public Works-Environmental Division
EAB	Enhanced Anaerobic Bioremediation
ECC	Environmental Chemical Corporation
EPS	Environmental Priority Service
eV	Electron-Volt
EWMC	Environmental Waste Management Center
FSA	Feasibility Study Addendum
FSM	Field Site Manager
ft	Feet
g	Grams
g/Kg	Grams per kilogram
GC	Gas Chromatograph
Greenfield	Greenfield Contractors
GeoCore	GeoCore Services, Inc.
HDPE	High Density Polyethylene
ID	Inside diameter
IDW	Investigative Derived Waste
IDWMP	Investigative Derived Waste Management Plan
IRP	Installation Restoration Program
IWSAP	Installation-Wide Sampling and Analysis Plan
J	Estimated
KAW	Kaw Valley Engineering
KDHE	Kansas Department of Health and Environment
kg	Kilogram

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

KGS	Kansas Gas Service
$KMnO_4$	Potassium Permanganate
LBA	Louis Berger & Associates
LTM	Long Term Monitoring
MCL	Maximum Contaminant Level
MH	Manhole
mL	Milliliter
MnO_4^-	Permanganate
MP	Malcolm Pirnie Inc
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean Sea Level
$NaMnO_4$	Sodium Permanganate
NCP	National Contingency Plan
ND	Not Detected
NOD	Natural Oxidant Demand
NOM	Natural Organic Matter
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Unit
OD	Outside Diameter
ORP	Oxidation Reduction Potential
OU	Operable Unit
PCE	Tetrachloroethylene
PID	Photoionization Detector
POC	Point of Contact
ppm	Part per million
Psi	Pounds per square inch
PSR	Pilot Study Report
PSWP	Pilot Study Work Plan
PVC	Polyvinyl Chloride
PWE	Fort Riley Directorate of Public Works-Environmental Division
QA	Quality Assurance
QA Lab	Chemical Quality Assurance Branch of Waterways Experiment Station
QC	Quality Control
RI	Remedial Investigation
RIA	Remedial Investigation Addendum
RIAMER	Remedial Investigation Addendum Monitoring Expansion Report
RPMP	Real Property Master Plan
RSK	Risk-Based Standard
TCE	Trichloroethylene

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TCLP	Toxicity Characteristic Leaching Procedure
UIC	Underground Injection Control
ug/kg	Micrograms per Kilogram
ug/L	Micrograms per Liter
UN	United Nations
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VCT	Vitreous Clay Tile
VOC	Volatile Organic Compound
yd^3	Cubic Yard

* * * * *

1.0 PROJECT BACKGROUND

This Pilot Study Report (PSR) has been prepared to present the data collected during the pilot study conducted for the Dry Cleaning Facilities Study Area (DCF) (Operable Unit [OU] 003). The pilot study was conducted to determine if soil and groundwater contamination identified during previous field investigations could be treated with in-situ and ex-situ remedial technologies.

This PSR provides the data collected during the pre-treatment, treatment, and post-treatment phases of the pilot study and was developed in support of the Fort Riley Directorate of Public Works-Environmental Division (PWE) Installation Restoration Program (IRP). Burns & McDonnell Engineering Company, Inc. (BMcD) provides engineering and consulting services in the environmental field. Environmental Chemical Corporation (ECC) has subcontracted BMcD to produce this PSR. ECC has a contract with the United States Army Corps of Engineers (USACE), Kansas City District, through which environmental field activities and reporting are conducted. This report represents Fort Riley's on-going commitment to investigate and take appropriate actions at sites posing a potential threat to human health and the environment.

1.1 INTRODUCTION

Fort Riley is located in north-central Kansas (Figure 1-1). The more developed areas of Fort Riley are located in the southern portion of the reservation along the Kansas River. The DCF is located on Main Post, just north of the Kansas River and includes the former Buildings 180/181 and Buildings 183/184 areas located north of the Union Pacific Railroad (UPRR) tracks, the Island area located south of the UPRR, and the Horse Corral located east of the Island (see Figure 1-2). The specific areas of concern (AOCs) addressed during the DCF pilot study consist of the following:

- AOC 1 - Two soil areas located beneath and adjacent to former Building 180/181 and Manhole (MH) 363, soil and backfill surrounding the abandoned high pressure gas line (AGL), the sanitary sewer line from MH 367 to MH 365, and the soil and backfill surrounding selected sanitary sewer lines in the utility corridor.

- AOC 2 - the groundwater within the bedrock erosional channel near Monitoring Well DCF06-40.

- AOC 3 - the groundwater and soil in the terrace aquifer near Monitoring Well DCF02-42 and DCF 06-25.

- Other Areas - the alluvial aquifer at Monitoring Wells DCF 02-49c, DCF 99-37c, and B354 99-11c.

The treatment areas contain soil and groundwater contaminated with one or more of the following contaminants: tetrachloroethylene (PCE), trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), and vinyl chloride (VC). These contaminants are present at concentrations above the United States Environmental Protection Agency (USEPA) maximum contaminant levels (MCLs) for groundwater and the Kansas Department of Health and Environment (KDHE) Risk-Based Standards (RSKs) (KDHE, 2003) for the non-residential soil to groundwater pathway and the groundwater pathway.

The following remedial technologies were evaluated during the pilot study conducted at DCF in 2005-2006:

In-Situ

- Enhanced anaerobic bioremediation (EAB) – groundwater
- Chemical oxidation – groundwater and soil

Ex-Situ

- Excavation and landfarming of shallow contaminated soil

The effectiveness of these treatment technologies were evaluated in this report for applicability to the DCF site and other sites at Fort Riley.

1.2 SITE HISTORY AND CONTAMINANTS

The dry cleaning facility at former Buildings 180/181 operated as a laundry facility from 1915 to 1983 and as a dry cleaning facility from 1930 to 1983. From 1983 onward until demolition in the summer of 2000, former Buildings 180/181 was used for general storage. Former Building 183 was initially used as a laundry facility from construction in 1941 until 2001, and as a dry cleaning facility from 1983 to 2001. During dry cleaning operations, stoddard solvent, a petroleum distillate mixture, was used as the cleaning solution from 1944 until 1966. From 1966 until dry cleaning operations ceased, PCE was used as the cleaning solution. Buildings 180/181 and 182 and the surrounding parking lots and sidewalks were demolished in summer 2000. Buildings 183 and 184, and most surrounding structures were demolished in fall 2002. The locations where Buildings 180/181, 183, and 184 once stood are now empty grassy lots.

These AOCs are currently classified by the Fort Riley Real Property Master Plan as a designated open area. Open areas have building restrictions and are used for safety areas, utility clearances and easements, conservation areas, and buffer zones.

1.3 HISTORICAL DATA REVIEW

Previous discussions of the DCF and the specific areas for the pilot study are provided in:

- *Remedial Investigation Report (RI), Dry Cleaning Facilities Area, Fort Riley, Kansas*, Louis Berger & Associates (LBA, 1995)
- *Remedial Investigation Addendum Monitoring Expansion Report (RIAMER), Dry Cleaning Facilities Area, Fort Riley, Kansas*, (LBA, 1998)
- *Technical Memorandum Report, Potential Source Area and Sewer Line Field Screening, Dry Cleaning Facilities Area (OU 003), Fort Riley, Kansas*, (BMcD, 2002)
- *Remedial Investigation Addendum (RIA) for the Dry Cleaning Facilities Area (OU 003) at Fort Riley, Kansas* (BMcD, 2003a)
- *Feasibility Study Addendum (FSA) for the Dry Cleaning Facilities Area (Operable Unit 003) at Main Post, Fort Riley, Kansas*, (BMcD, 2005a)

These reports provide detailed information on setting, previous investigations, the nature and extent of contamination, fate and transport, human and ecological risk assessments, and the current monitoring well network. The following sections provide only summaries. Refer to the previous reports for more comprehensive information.

1.3.1 Site Geology

Alluvial terraces and river alluvium of the Kansas River dominate the topography across the DCF. The Kansas River flows through the DCF in a general west to east direction. There are also two ephemeral streams within the DCF: Tributary A, which lies immediately east of former Buildings 180/181 and Tributary B, which is located on the Island (Figure 1-2).

The portion of the DCF located north of the UPRR grade (Dry Cleaning Facilities Area [DCFA]), is composed of two alluvial terraces. These terraced areas are composed of material deposited during flooding of the Kansas River, erosion of upland areas north of DCF, or placement of fill material (anthropogenic) along the western boundary of Tributary A. Inlets carved into the terrace walls are the results of flooding and intermittent stream erosion. The topography of the terrace in this area generally rises to the north. Elevations vary from about 1,062 feet (ft) above mean sea level (msl) along the UPRR grade to approximately 1,126 ft above msl north of former Building 183.

The Island and Horse Corral areas are underlain by Kansas River alluvium. The Kansas River alluvium is composed of Kansas River flood deposits and erosional deposits from the upland and terrace areas. The Island and the Horse Corral lie between the UPRR grade and the Kansas River, west of Henry Drive Bridge. Both areas are of low relief, with ground surface elevations generally between 1,046 ft above msl near the Kansas River to 1,065 ft above msl on the Island.

Between the Kansas River alluvium and the alluvial terraces is a Transition Zone interspersed with erosional deposits from the upland and terrace areas. The topography of the Transition Zone rises abruptly from the alluvial point bars to the terrace areas in a north/south direction, but rises gradually along the UPRR grade from the east to west direction. Elevations vary in the north/south direction between 1,046 ft above msl at the base of the UPRR grade to approximately 1,066 ft above msl on the UPRR track. Elevations vary in the east/west direction between about 1,064 ft above msl at the UPRR tracks at Henry River Bridge, to 1069 ft above msl at the UPRR train trestle.

Geology of the alluvial terraces 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 180. The axis of the channel runs northeast/southwest and slopes to the southwest and extends through the Transition Zone into the Island. Sand is present within the bedrock erosional channel. The Transition Zone is composed of Kansas River alluvium interspersed with erosional 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 fining upwards into a fine sand with an upper layer of silty clay/clayey silt present in places. Soils beneath the Island and Horse Coral are also composed primarily of alluvial sediment deposited by the Kansas River. Subsurface lithologies in these areas also represent an upward-fining sequence typical of alluvial point bar and floodplain sediments.

1.3.2 Site Hydrogeology

The aquifers beneath the DCF consist of unconfined terrace aquifers, alluvial unconfined aquifers, and semi-confined bedrock aquifers. In general, the terrace aquifers are thin and lie immediately above bedrock, while the alluvium aquifers show a fining upward sequence typical of river alluvial sediments. The underlying Permian bedrock has a much lower porosity and permeability, although fractures and solution features may provide conduits for groundwater flow.

Current groundwater flow conditions for the DCF show a south, southeast direction of flow toward the Kansas River with hydraulic conductivities ranging from 0.51 ft/day in silty sand to 0.0018 ft/day in lean clay (BMcD, 2003a) based on geotechnical permeability tests. The hydraulic conductivity reported for the bedrock erosional channel based on slug tests was 69.31 ft/day. Groundwater flow within the alluvial valley is controlled by the Kansas River and generally conforms to the direction of river flow. The hydraulic conductivity reported for the Kansas River alluvium at a site downgradient of the DCF is 737 ft/day based on aquifer test conducted by the USACE (BMcD, 2003a).

The groundwater velocity for the DCF, using the simple linear formula $V=KI/n$, where V equals groundwater velocity in feet per day, K equals hydraulic conductivity, I equals hydraulic gradient, and n equals porosity, ranges from 3.6×10^{-6} ft/day (less than a 1/1000 of a foot per year) to 0.14 ft/day (50.5 ft/year). It is important to note that the linear groundwater velocity equation does not factor into the result the protracted effects caused by dispersion, absorption, vertical and horizontal porosity and permeability variations, dilution, volatilization, and flood event bank recharge. The combined and temporal cumulative effect for these parameters exerts a reduction in contaminant plume velocity and migration.

The terrace aquifer is not likely to ever be used as a source of drinking water due to the limited amount of groundwater present and the quantity of groundwater in nearby alluvial aquifers. It is also improbable, due to critical eagle habitat, that the alluvial aquifer on the Island would be used as a source for drinking water.

1.3.3 Site Analytical

The major findings of the RIA and FSA Reports are listed below. The AOCs and other areas are shown on Figure 1-2.

- PCE was present in the soil at concentrations above the KDHE RSKs to a maximum depth of 12 ft at two shallow soil source areas at AOC 1.
- PCE, TCE, cis-1,2-DCE, and VC were detected at levels greater than MCLs in groundwater at AOCs 2 and 3, and are contaminants of potential concern (COPCs) for the groundwater media. TCE, cis-1,2-DCE, and VC are the degradation products of the PCE that leaked from broken and cracked sanitary sewer lines. The groundwater contamination at the DCF extends from the DCFA to the Kansas River and generally sinks with distance from the DCFA. Analytical samples collected from the Kansas River were nondetect for the COPCs.

- At AOC 2, groundwater contamination is naturally reduced upon entering the Kansas River alluvium to levels below MCLs. Natural attenuation is not reducing COPCs to levels below the MCL in groundwater at AOC 3.

- Additional Areas with contaminant levels slightly above MCLs and limited extent include the VC contamination at DCF93-19 and the PCE contamination at DCF02-49c, DCF99-37c and B354-99-11c.

1.3.4 Site Human Health Risk

The human health risk assessment in the RIA (BMcD, 2003a) characterized potential health effects for on-post populations through direct contact with surface soil, subsurface soil, and sediment pore water in the Kansas River; and through inhalation of dust and chemical vapors from soil or groundwater exposure pathways. The on-post populations (those within the Fort Riley Army Reservation) characterized for the risk assessment included groundskeeper, utility worker, and youth trespasser scenarios.

The total excess lifetime cancer risks for the on-post populations were:

- Groundskeeper - 6.0 x 10^{-11}
- Utility Worker - 2.0 x 10^{-10}
- Youth Trespasser - 2.0 x 10^{-08}

All of these are below the National Contingency Plan's (NCP's) generally acceptable risk range of up to 1.0 x 10^{-04} to 1.0 x 10^{-06} (or 1 in 10,000 to one in a million).

1.3.5 Site Ecological Risk

The DCF was evaluated for the presence of ecological receptors (plants, animals, and aquatic organisms) and completed ecological exposure pathways in surface soils, subsurface soils, and groundwater in the RIA (BMcD, 2003a). Potentially completed exposure pathways were identified at the DCF, and these pathways were evaluated. Representative terrestrial receptors were assessed semi-quantitatively. Based on the results of the semi-quantitative and qualitative evaluations of soil contaminants, ecological risk is minimal to terrestrial flora and fauna inhabiting the DCF.

Potential for risk to aquatic organisms inhabiting the Kansas River was assessed semi-quantitatively. Current volatile organic compound (VOC) concentration conditions within the river sediment are unlikely to pose appreciable risk to aquatic organisms in the Kansas River. Critical habitat for the bald eagle, piping plover, and interior least tern occurs along the Kansas River. There is minimal ecological risk to these species at the DCF.

* * * * * *

2.0 PROJECT SCOPE AND OBJECTIVES

This section of the PSR provides the project scope and objectives, a descriptive overview of each treatment area based on previous investigation studies, and a review of applicable regulations and standards. Site specific information for the DCF and the AOCs addressed under this pilot study are provided in the following reports:

- *Remedial Investigation Report (RI), Dry Cleaning Facilities Area, Fort Riley, Kansas*, Louis Berger & Associates (LBA, 1995)
- *Remedial Investigation Addendum Monitoring Expansion Report (RIAMER), Dry Cleaning Facilities Area, Fort Riley, Kansas*, (LBA, 1998)
- *Technical Memorandum Report, Potential Source Area and Sewer Line Field Screening, Dry Cleaning Facilities Area (OU 003), Fort Riley, Kansas*, (BMcD, 2002)
- *Remedial Investigation Addendum (RIA) for the Dry Cleaning Facilities Area (OU 003) at Fort Riley, Kansas* (BMcD, 2003a)
- *Feasibility Study Addendum (FSA) for the Dry Cleaning Facilities Area (Operable Unit 003) at Main Post, Fort Riley, Kansas*, (BMcD, 2005a)

These reports provide detailed information on setting, previous investigations, the nature and extent of contamination, fate and transport, human and ecological risk assessments, current monitoring well network and the locations for manholes, and sewerlines. The following sections provide a descriptive overview of each AOC. Refer to the previous reports for more comprehensive information.

2.1 PROJECT OBJECTIVES

The project objectives for implementation of this pilot study are:

- Determine the feasibility of ex-situ treatment of shallow soil contamination using excavation and landfarming and in-situ treatment of the utility corridor at AOC 1 using chemical oxidation.
- Determine the feasibility of full-scale in-situ treatment of groundwater contamination using EAB at AOC 2.

- Determine the feasibility of full-scale in-situ treatment of soil and groundwater contamination using chemical oxidation at AOCs 1 and 3 and other areas.
- Maximize the areas treated and the contaminant mass removed.
- Provide additional soil and groundwater contamination characterization as an ancillary benefit.

For pilot-scale application of in- and ex-situ treatments at the DCF, the *Work Plan, Pilot Study for Soil and Groundwater Remediation, DCF Study Area (Operable Unit 003) at Main Post, Fort Riley, Kansas,* (ECC/BMcD 2006) was prepared to provide the rationale and detailed guidance for field personnel to apply and evaluate the treatment of contaminated soil and groundwater. The necessity for a treatability study was triggered by exceedances of screening criteria established for the protection of groundwater.

2.2 TREATABILITY STUDY OBJECTIVIES FOR AOC 1

2.2.1 Area #1 and Area #2 Soils

Area #1 and Area #2 consist of two areas of soil contamination near former Buildings 180/181 that contained shallow, chlorinated solvent contaminated soil above the KDHE RSKs (see Figure 2-1). Precipitation as well as sewer line leakage moving downward through the vadose zone and into the contaminated soil in these two areas have resulted in chlorinated solvents migrating to groundwater at depth. This contamination has subsequently been transported via groundwater southward to the Kansas River alluvial aquifer. PCE was detected at concentrations that exceeded the KDHE RSK of 180 micrograms per kilogram (μg/kg) for the soil to groundwater protection pathway to approximately 12 ft below ground surface (bgs). PCE concentrations for subsurface soils are presented on Table 2-1. The size of the excavation treatment area for Area #1 South was approximately 30 ft by 125 ft to a depth of 8 ft and the size of the excavation treatment area for Area #1 North was approximately 45 ft by 60 ft to a depth of 8 feet. The size of the excavation treatment area for Area #2 was irregular in shape and was approximately 28 ft by 43 ft to a depth of 8 ft. Area #2 also contained a limited area with PCE concentrations that exceeded the KDHE RSK of 180 μg/kg to a depth of 12 ft bgs. This area was approximately 24 ft by 13 ft to a depth of 12 ft.

The purpose of the pilot study for soil remediation at AOC 1 was to evaluate effective remedial technologies that would achieve the desired cleanup objectives at a reasonable cost. Following completion of the detailed analysis of alternatives in the FSA (BMcD, 2005a), the remedial option that best satisfied the cleanup objectives for shallow soil remediation was soil excavation with landfarm treatment. With this option, shallow soil contaminated with PCE was excavated and transported to a landfarm treatment cell located at Camp Funston (see Figure 2-2). The selection of this ex-situ soil treatment method for AOC 1 was made for the following reasons:

- To evaluate the effectiveness of shallow soil excavation and landfarming.
- To evaluate whether removal of the contaminated soil will prevent infiltration of precipitation through a contaminated soil zone to subsurface groundwater.
- To evaluate whether this treatment method reduces long-term monitoring time and cost.

2.2.2 Utility Corridor

The utility corridor treatment area was part of the pilot study based on previous sewer line investigations conducted in 1992, 1993, and 1994 (RI, LBA, 1995) in which sanitary/storm sewer sediment samples had elevated concentrations of PCE (470,000 μg/kg), TCE (15,000 μg/kg) and cis-1,2-DCE (160,000 μg/kg) at MH 363. It is suspected that leaking dry cleaning process waste water from the former Buildings 183/184 area backed up into the AGL corridor and the sanitary sewer line corridor located near MH 363. The waste water backup may have caused chlorinated solvent contamination of soil, sediment, and backfill in this area. The utility corridor treatment area was divided into two locations, one location south of Custer Road and the other location north of Custer Road. The first location included the AGL and the MH 363 area and extended from MH 363 northward before the corridor turns westward along Custer Road. The second portion was located at MH 367 and extended southeast toward MH 365 and MH 363 area (see Figure 2-3). Soil removed during excavation was field screened for contaminants and the soil was removed to the landfarm treatment cell for treatment if soil vapor readings above 1 part per million (ppm) were detected. Following excavation, an in-situ soil treatment method of sodium permanganate ($NaMnO_4$) solution was injected at the first location to the sanitary sewer line between MH 363 and 365, to MH 365, to the excavation around MH 365, and portions of the AGL. For the second location, an in-situ soil treatment method of $NaMnO_4$ solution was injected to the sanitary sewer line at MH 367. Treatment was applied to these areas based on the following reasons:

- To evaluate the utility corridor as a conduit for the transport of process waste water contamination.
- To evaluate chemical oxidation as a viable technical option for the treatment of the utility corridor.

- To evaluate whether chemical oxidation will reduce soil, sediment, and backfill contamination within the utility corridor to concentrations below the KDHE RSKs (KDHE, 2003).

- To evaluate whether this treatment method reduces long-term monitoring time and cost.

2.3 TREATABILITY STUDY OBJECTIVES FOR AOC 2

Contaminated groundwater in AOC 2 is located within a bedrock erosional channel in the vicinity of Monitoring Well DCF06-40 (Figure 2-4). The axis of the channel is oriented in a northeast/southwest direction and extends under the UPRR to the Kansas River alluvium. Portions of this channel lie beneath the former Building 180 location. The groundwater contamination for AOC 2 has been mostly attenuated based on the groundwater analytical results from monitoring wells screened in this channel (see Table 2-2). These monitoring wells include DCF92-05, DCF93-13, DCF06-40, and DCF 02-41. To reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSKs and MCLs of 5 microgram per Liter (µg/L) for PCE and TCE as well as to decrease the monitoring time for AOC 2, a pilot study involving EAB was conducted (see Figure 2-4).

The selection of the EAB groundwater treatment method for AOC 2 was made for the following reasons:

- To evaluate EAB as a viable technical option for the treatment of the groundwater contamination.

- To evaluate EAB as an effective method to enhance the natural attenuation of groundwater in the bedrock erosional channel.

- To evaluate if EAB will reduce groundwater contamination within AOC 2 to concentrations below the KDHE RSKs (KDHE, 2003) and the USEPA MCLs.

- To evaluate if EAB will reduce long-term monitoring time and cost.

2.4 TREATABILITY STUDY OBJECTIVES FOR AOC 3

2.4.1 Vadose Zone

In AOC 3, it is suspected that subsurface soil in the vadose zone near Monitoring Well DCF02-42 was contaminated by leaking dry cleaning process waste water from the former Buildings 180/181 area or from MH overflow at the former Building 183/184 area. The soil in the vadose zone located between the bottom of the AGL and the water table interface was analyzed by an on-site laboratory and treated with a $NaMnO_4$ solution (Figure 2-5). Before application of this treatment technology, a soil matrix treatability study was conducted to evaluate the natural oxidant demand (NOD) of the soil within the vadose zone.

The NOD is primarily a function of the natural organic content of the soil and the oxidizable minerals/mineral surfaces present. The selection of this in-situ soil treatment method was made for the following reasons:

- To evaluate the chemical oxidation treatment method for remediation of vadose zone soil contamination near Monitoring Well DCF02-42.
- To evaluate whether chemical oxidation will reduce or eliminate the leaching of groundwater through a contaminated soil zone.
- To evaluate whether chemical oxidation will reduce long-term monitoring time and cost.

2.4.2 Groundwater

Contaminated groundwater is present near Monitoring Well DCF02-42 and extends southeastward to Monitoring Well DCF 06-25, which is approximately 230 ft downgradient (Figure 2-6). This area is located in the western portion of the DCF and is the approximate point where the western plume enters the Kansas River alluvium. The analytical results from the October 2005 baseline groundwater sampling event are presented in Table 2-2. Historically, analytical results have indicated that PCE, TCE, and cis-1,2-DCE concentrations are approximately the same for both of these two monitoring wells. For the October 2005 groundwater sampling event, Monitoring Well DCF02-42 was dry. To reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSKs and MCLs of 5 μg/L for PCE and TCE as well as decrease the monitoring time for AOC 3, a pilot study involving chemical oxidation injection of potassium permanganate ($KMnO_4$) was conducted.

Before application of this treatment technology, a bench-scale test of the groundwater and an aquifer matrix treatability study was conducted to evaluate the NOD. The NOD is primarily a function of natural organic content, oxidizable minerals/mineral surfaces, and oxidizable material dissolved or suspended in the groundwater.

The selection of this groundwater treatment method was made for the following reasons:

- To evaluate chemical oxidation as a viable technical option for the treatment of the groundwater contamination.
- To evaluate whether chemical oxidation will reduce groundwater contamination within AOC 3 to concentrations below the KDHE RSKs (KDHE, 2003) and the USEPA MCLs.

- To evaluate whether chemical oxidation will reduce long-term monitoring time and cost.

2.5 TREATABILITY STUDY OBJECTIVES FOR OTHER AREAS

2.5.1 Groundwater at Monitoring Well DCF 02-49c

Contaminated groundwater is also present on the Island near the Kansas River at Monitoring Well DCF 02-49c (Figure 1-2 and Table 2-2). To reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSK and MCL of 5 µg/L for PCE as well as to decrease the monitoring time for this area, a pilot study involving EAB was conducted. The selection of the EAB groundwater treatment method for this area was made for the following reasons:

- To evaluate EAB as a viable technical option for the treatment of the groundwater contamination.
- To evaluate EAB as an effective method to stimulate the natural attenuation of groundwater in this area.
- To evaluate whether EAB will reduce groundwater contamination within this area to concentrations below the KDHE RSKs (KDHE, 2003) and the USEPA MCLs.
- To evaluate whether EAB will reduce long-term monitoring time and cost.

2.5.2 Groundwater in Horse Corral Area at Monitoring Wells DCF 99-37c and B354-99-11c

Contaminated groundwater is also present at two separate areas near the Horse Corral located near Monitoring Well DCF 99-37c and B354 99-11c (Figure 1-2 and Table 2-2). To reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSK and MCL of 5 µg/L for PCE as well as to decrease the monitoring time for this area, a pilot study involving EAB was conducted. The selection of the EAB groundwater treatment method for these two areas was made for the following reasons:

- To evaluate EAB as a viable technical option for the treatment of the groundwater contamination.
- To evaluate EAB as an effective method to enhance the natural attenuation of groundwater in these two areas.
- To evaluate whether EAB will reduce groundwater contamination within these two areas to concentrations below the KDHE RSKs (KDHE, 2003) and the USEPA MCLs.
- To evaluate whether EAB will reduce long-term monitoring time and cost.

2.6 APPLICABLE REGULATIONS AND/OR STANDARDS

For this pilot study, soil was the matrix of interest in AOCs 1 and 3 and groundwater was a matrix of interest in AOCs 2 and 3 and the other areas. The treatment areas contained soil and groundwater contaminated with one or more of the following contaminants: PCE, TCE, cis-1,2-DCE, and VC. The contaminants are present at concentrations above the USEPA MCLs for groundwater and the KDHE RSKs (KDHE, 2003) for the non-residential soil to groundwater pathway and the groundwater pathway. MCLs for PCE, TCE, cis-1,2-DCE, and VC are 5, 5, 70, and 2 μg/L, respectively. The KDHE RSKs for the soil to groundwater protection pathway (non-residential scenario) for PCE, TCE and cis-1,2-DCE in soil are 180 μg/kg, 200 μg/kg and 800 μg/kg, respectively.

* * * * * *

3.0 FIELD ACTIVITIES

3.1 SUMMARY OF FIELD ACTIVITIES

This section provides a summary of the field work conducted at the DCF site during the pilot study. The analytical results for the field work are presented in Section 4 of this report. In general, the field work conducted for the pilot study consisted of the following activities which are presented in the approximate order that they were performed:

- Applied and obtained UPRR property access agreements.
- Performed magnetometer survey to identify abandoned and current underground utilities at the AGL near former Building 180, at the former MH 367 area, and adjacent to Monitoring Well DCF02-42.
- Obtained KDHE Class V injection permit for chemical oxidation and EAB injection.
- Conducted fall 2005 groundwater sampling event.
- Marked out utility locations in the pilot study areas.
- Abandoned Monitoring Well DCF01-40.
- Revitalized existing landfarm treatment cell.
- Assessed subsurface vadose zone near Monitoring Well DCF02-42.
- Collected soil and groundwater samples from AOC 3 to support the treatability bench studies.
- Conducted treatability bench study on soil and groundwater samples collected from the site.
- Excavated and removed soil from AOC 1 from the southern and northern portions of Area #1 and transported to the landfarm treatment cell followed by backfilling, compaction, and grading of the treated area.
- Excavated and removed soil from AOC 1-Area #2 to landfarm treatment cell followed by backfilling, compaction, and grading of the treated area.
- Excavated the AGL followed by chemical oxidation treatment, backfilling, and compaction. Excavation was conducted starting at the storm sewer grate and extended westward paralleling Custer Road. Selected soil samples were analyzed using an on-site field gas chromatograph (GC) to determine the extent of westward utility corridor excavation based on soil contamination.
- Excavated MH 363 and the surrounding area followed by chemical oxidation treatment, backfilling, and compaction.
- Excavated MH 367 followed by chemical oxidation treatment, backfilling, and compaction.
- Conducted vadose zone injections at Monitoring Well DCF02-42 area.
- Conducted spring 2006 groundwater sampling event.

- Installed piezometer on the Island between Monitoring Well DCF02-42 and Monitoring Well DCF06-25.
- Conducted multiple tilling cycles on soil excavated from AOC 1 at the landfarm treatment cell.
- Conducted multiple soil sampling cycles from soil at the landfarm treatment cell.
- Applied and obtained UPRR horizontal boring permit.
- Removed treated soil from the landfarm treatment cell.
- Removed the landfarm treatment cell.
- Excavated, drilled, and installed three horizontally-bored, 3-inch pipe runs for high pressure chemical feed lines.
- Performed chemical oxidation pilot study at AOC 3.
- Performed EAB pilot study at AOC 2.
- Performed pilot study post performance monitoring for AOC 2 and AOC 3.
- Conducted EAB pilot study at Monitoring Well DCF02-49c.
- Conducted EAB pilot study at Monitoring Well DCF99-37c.
- Conducted EAB pilot study at Monitoring Well B354-99-11c.
- Conducted fall 2006 groundwater sampling event.
- Conducted winter 2007 reduced groundwater sampling event.
- Conducted spring 2007 groundwater sampling event (other consultant).

3.2 SUPPORTING DOCUMENTATION

The field procedures that were used during performance of the DCF Pilot Study are based on the standard procedures discussed in the following documents:

- *Installation-Wide Sampling and Analysis Plan for Environmental Investigations at Fort Riley, Kansas (IWSAP)*, [Malcolm Pirnie (MP)-BMcD, 2004a]
  - *Volume I Field Sampling Plan*
  - *Volume II Quality Assurance Project Plan*
- *Installation-Wide Quality Control Plan for Environmental Studies and Investigations at Fort Riley, Kansas* (MP-BMcD, 2004b)
- *Installation-Wide Site Safety and Health Plan for Environmental Investigations at Fort Riley, Kansas*, [MP-BMcD, 2004c]
- *Installation-Wide Investigative Derived Waste Management Plan* (IDWMP) *For Environmental Investigations, Fort Riley, Kansas* (BMcD, 2003b)

3.3 SUBCONTRACTORS

The following subcontractors performed specific services during the pilot study with BMcD oversight:

- SeaBreeze Technologies, LLC provided Cap 18 and EAB consulting services.
- Colog Division – Layne Christensen Company, performed the magnetometer surveys.
- Greenfield Contractors (Greenfield), the excavation subcontractor performed all treatment cell renovations, soil removal, soil backfilling, soil compaction, soil treatment support, and landscaping.
- Continental Analytical Services (CAS), the analytical laboratory, performed all soil and groundwater laboratory analyses.
- Environmental Priority Service (EPS), the direct-push subcontractor, performed direct-push services for soil sampling; EAB and chemical oxidation injection applications at AOC 2, AOC 3, and other areas; on-site analysis for the AGL assessment; piezometer installation, and monitoring well installation on the Island (DCF06-25).
- GeoCore Services, Inc. (GeoCore), the drilling subcontractor, performed the monitoring well abandonment (DCF01-40) and replacement (DCF06-40).
- FRx performed chemical oxidation slurry emplacement services in groundwater at AOC 3.
- M&D Excavating of Hays, Kansas performed horizontal boring activities at AOC 3.
- KAW Valley Engineering (KAW) of Junction City, Kansas performed survey services.
- Carus Chemical Company of LaSalle, Illinois supplied the permanganate and treatability study.

3.4 CLASS V INJECTION PERMIT

A Class V Underground Injection Control (UIC) Well application for remediation projects for EAB and chemical oxidation injection at the DCF was submitted on November 1st, 2005 to Mr. Kirk Hoeffner, Unit Chief, UIC Program, KDHE (Appendix A). BMcD received UIC authorization for remediation injection for this project on November 8th, 2005.

3.5 FALL 2005 GROUNDWATER SAMPLING EVENT

A groundwater sampling event was conducted during October 2005 to provide a baseline for chlorinated solvent concentrations. Although this event was not tasked under this pilot study, it is included in the PSR because it was conducted immediately prior to the pilot study startup and provides the baseline data necessary for conducting a performance evaluation. The VOC results for this event are reported in Section 4 of this PSR and in the *Quality Control Summary Report, Fall 2005 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2005b). Baseline natural attenuation parameters were collected during the spring 2005 groundwater sampling event and can also be found in the *Data Summary Reports, Spring 2005, Fall 2005, Dry Cleaning Facilities Area, at Fort Riley, Kansas,* (BMcD, 2005c). The natural attenuation baseline concentrations for the spring 2005 groundwater sampling event are reported in Section 4. The monitoring well network is shown on Figure 1-2.

3.6 UTILITY LOCATIONS

3.6.1 General

The mark out of underground utilities by both commercial and Fort Riley utility locators was completed before beginning fieldwork. Commercial utilities were cleared by calling Kansas One Call and Fort Riley Dig Safe before beginning any intrusive field activities. During the pilot field effort, the BMcD field site manager (FSM) updated the utility clearance every 15 days with Fort Riley and Kansas 1 Call.

3.6.2 Abandoned High Pressure Gas Line

A representative from Kansas Gas Service (KGS) provided field support in locating the AGL, which is located south of Custer Road in the area of former Building 180/181. The KGS representative was also on site during all excavation and subsurface injection activities conducted within 50 feet of the active gas line. The position of the AGL was located and marked by the KGS representative as shown on Figure 2-1. The AGL was located adjacent to Custer Road and extended westward from the storm water catch basin for approximately 250 feet before it angles northwest and travels beneath the paved portion of Custer Road. The active high pressure gas line is located further south of the AGL in the former Building 180/181 area. The active gas line replaces the AGL in the utility corridor once the line travels beneath Custer Road in both the east and west direction (Figure 2-1). The KGS representative indicated that the AGL was removed from beneath Custer Road and replaced with the newer high pressure gas line. The only gas line that currently exists near Monitoring Well DCF 02-42 is the newer high pressure gas line.

3.6.3 Railroad Access

Access to the UPRR right-of-way was required in order to complete AOC 3 chemical oxidation injection and piezometer installation tasks outlined in the Pilot Study Work Plan (PSWP). A basic Right of Entry Application was submitted and approved by the UPRR to move equipment to and from AOC 3. A Horizontal Boring Access Agreement was also submitted and approved by the UPRR for drilling horizontal borings beneath the UPRR grade. Both applications were submitted to Ms. Ernestine W. Burtley in Omaha, Nebraska (Appendix B). A summary of the application procedures is provided in the following text.

3.6.3.1 Basic Right of Entry

The Basic Right of Entry Agreement required a completed application form, a non-refundable application fee, a site figure showing the access/egress points, railroad protective liability insurance, general public liability insurance, automobile liability insurance, and worker's compensation insurance. When the application was approved, BMcD obtained clearance and approval from the UPRR Company's Fiber Optic Cable Hotline. Following approval, arrangements were made with Mr. Larry Huddleston, the UPRR Company's local manager of track maintenance, for access scheduling. The Basic Right of Entry Permit was activated for one year only and expired in March 2007.

3.6.3.2 Horizontal Boring Access Agreement

To reduce the amount of anthropogenic damage to the Island area (AOC 3) during chemical oxidation injection activities, the permanganate mixing and storage equipment was staged north of the UPRR tracks and slightly west of Monitoring Well DCF02-42. Staging of the equipment in this area required the installation of chemical oxidation feed and water lines beneath the UPRR grade. For horizontal boring activities beneath the UPRR grade, a special application package was submitted and approved by UPRR (Appendix B). This application package included a questionnaire, as-constructed engineer drawings, location figures, and a non-refundable application fee. Upon approval of the boring application by UPRR engineers, the horizontal borings and the chemical oxidation feed and water lines were installed by M&D Excavating under the supervision of BMcD personnel. A UPRR representative was also on site during boring fieldwork. Following completion of the pilot study remedial activities on the Island, the horizontal borings were grouted in place.

3.6.4 Magnetometer Surveys

Three magnetometer surveys were conducted during the week of November 15, 2005 to identify the location of selected utilities within the utility corridor. Magnetometer surveys are a type of geophysical investigation used to locate or detect buried underground utilities, tanks, pipelines, or drums whose location or even existence may not be known. The magnetometer is a tool that measures the intensity of the earth's magnetic field at multiple individual locations on a site. The survey was conducted by the Colog Division of Layne Christensen Company. The first survey was conducted in the utility corridor near the storm sewer catch basin and extended westward for approximately 200 ft (Figure 3-1). This grid was 40 feet wide and was conducted to locate the AGL. The second survey was conducted at the former MH 367 location and covered an area 30 ft wide and 100 ft long (Figure 3-1). This survey was conducted to locate former MH 367, which had been abandoned. The third survey was conducted near Monitoring Well DCF02-42 (see Figure 3-1) and covered an area 90 ft long and 10 ft wide. The third survey was conducted to locate the AGL and the high pressure gas line in this area. The magnetometer surveys are presented in Appendix C.

Prior to conducting the survey, the surface area was cleared of all metal objects and surface debris. This was completed because metallic objects at the surface (for example, man-hole covers, underground utilities, reinforced pavement, and other smaller metal objects) will also cause anomalies. Therefore, to differentiate these from potential subsurface anomalies, the site was cleared of these types of objects before the survey.

Once each survey area was cleared, a grid for each area was set up on 10-ft centers. Wooden and flagged stakes were placed at each 10-ft spacing node. To assist in the differentiation between larger deep objects from shallow small objects, the geophysical survey team conducted a preliminary sweep with a conventional metal detector to screen out small shallow objects. Following the preliminary sweep, the survey was conducted by the magnetometer on 10-ft parallel line spacing. Following data collection, contour maps of the data were generated for each survey area showing any apparent anomalies (Appendix C).

3.7 MONITORING WELL DCF01-40

Monitoring Well DCF01-40 was located within the southern excavation area of Area #1 and was abandoned prior to commencing soil removal activities (Figure 2-1). As Monitoring Well DCF01-40 is an integral part of the monitoring well network at the DCF, it was replaced after Area #1 had been backfilled with Monitoring Well DCF06-40. Monitoring Well DCF01-40 was abandoned and DCF06-40 was reinstalled by GeoCore of Salina, Kansas.

3.7.1 Abandonment of Monitoring Well DCF01-40

Upon arrival at the DCF, the drilling subcontractor (GeoCore) constructed a decontamination pad and decontaminate all equipment before commencing abandonment operations. All investigative derived waste (IDW) generated during the field activity was handled according to procedures presented in the site-specific IDWMP. Liquid IDW generated during decontamination procedures was collected and stored in a United Nations (UN) approved drum. Following completion of well abandonment activities, the decontamination water was transferred to the holding tank at the landfarm treatment cell for storage.

Monitoring Well DCF01-40 was abandoned on November 14, 2005 according to KDHE Article 30, Water Well Construction and Abandonment, Attachment B, as required by K.A.S. 82a-1201 to 82a-1215. The monitoring well pad and protective cover was removed and transported to the Campbell Construction Debris (CD) landfill for disposal. The casing and screen was pulled and the borehole was backfilled with

3/8-inch bentonite chips starting at the depth the soil collapsed into the borehole. The chips were hydrated in one-foot lifts. Chips were used instead of a slurry or grout because Monitoring Well DCF01-40 was to be replaced and the injection of a bentonite grout could reduce the permeability of the saturated zone in the area of the well.

3.7.2 Replacement with Monitoring Well DCF06-40

Following excavation and backfilling of Area #1 and Area #2, former Monitoring Well DCF01-40 was replaced on January 30, 2006 by GeoCore with Monitoring Well DCF06-40 (see Figure 1-3). The new location was two feet northeast of the previous well location. Monitoring Well DCF06-40 was installed using a Gus Peck 1000R hollow stem auger drilling rig. Upon arrival at the DCF, GeoCore personnel constructed a decontamination pad and decontaminated all equipment before commencing installation operations. Liquid IDW generated during decontamination procedures was collected and stored in a UN-approved drum. Following completion of well installation activities, the decontamination water was transferred to the holding tank at the landfarm treatment cell for storage. Soil sampling for logging purposes was not conducted.

Monitoring Well DCF06-40 was drilled to the bedrock/overburden interface at 45 ft bgs. Total depth of the well was 44.70 ft bgs. The bedrock was composed of a limey shale and was encountered at 43 ft bgs. A small limestone shelf was encountered at 37.5 ft bgs during drilling. This was determined by drilling rig sounds, hardness, and cuttings. The well screen was set approximately 2 ft into the shale bedrock to overlap the bedrock interface. The well was constructed with a 10-ft 0.010 slot Schedule 40 polyvinyl chloride (PVC) screen and 37 ft of PVC riser. The well was constructed with a 3-ft by 3-ft pad, a protective well cover, and three protective bollards. The protective cover and the bollards were painted with a "historic brown" color. A monitoring well diagram for Monitoring Well DCF06-40 is provided in Appendix D. The well was surveyed by KAW Valley Engineers of Junction City, Kansas (Appendix E).

3.7.3 Development of Monitoring Well DCF06-40

Monitoring Well DCF06-40 was developed on February 2nd, 2006 following a 48 hour wait time after grouting. Well development for Monitoring Well DCF06-40 was performed according to procedures described in Section 4.0 of the Monitoring Well Installation Plan (Appendix B, Section 4.0, MP-BMcD, 2004a) and selected portions of Chapter 6 in the Monitoring Well Design Engineer Manual USACE EM 1110-1-4000 (USACE, 1998), with the following modifications:

- A Waterra lift and surge pump was initially used for well development to remove sediment and simultaneously surge and pump the screened portion of the monitoring well. The screened portion of the well was developed in 2-ft intervals commencing at the top of the water table within the screen and moving downward toward the bottom of the monitoring well.

- The monitoring well purged dry before well stability had been achieved. Because the well purged dry three consecutive times, the well was considered developed.

Prior to well development, the static water level and total depth were recorded on a Well Development Form (Appendix D). Additionally, initial pH, conductivity, temperature, and turbidity measurements were recorded prior to commencement of well development. All instruments were calibrated according to manufacturers' specifications prior to use and as stated in the Field Sampling Plan. pH, conductivity, temperature, and turbidity measurements were used during well development as stabilization criteria. During well development, periodic measurements of the stabilization criteria were recorded on the Well Development Form.

3.8 VADOSE ZONE ASSESSMENT

The soil in the vadose zone near Monitoring Well DCF02-42 in AOC 3 was suspected to be contaminated by leaking drycleaning process waste water. The process waste water emanated from two separate locations: the first location was from the former Buildings 180/181 area due to waste water that backed up at MH 363 into the backfill surrounding the AGL and traveled westward toward Monitoring Well DCF02-42, and the second area was from waste water overflow of a MH 366 (see Appendix A, Historical Figures and Tables, Figure 3-4, PSWP) near former Building 183/184. To assess the current subsurface chlorinated solvent concentrations in this area, soil samples were collected from Boring TS-1 (Appendix F) for field analysis using direct-push technology. The direct-push work was performed by EPS of Salina Kansas with BMcD oversight.

Upon arrival at DCFA, EPS constructed a decontamination pad and decontaminate all equipment before beginning soil-sampling operations. Liquid IDW generated during decontamination procedures was collected and stored in a UN-approved drum. Following completion of direct-push activities, the decontamination water was transferred to the holding tank at the landfarm treatment cell for storage. The direct-push boring (TS-1) was located between Monitoring Well DCF02-42 and the active high pressure gas line (Figure 3-2). Soil samples were collected from the boring using a truck-mounted direct-push rig following the procedures outlined in Section 4.4.2 of the IWSAP (MP-BMcD, 2004a). A 4-ft macro-core (2-inch diameter) soil sampler with acetate liners was used for soil collection. The soil was sampled continuously from the ground surface to the water table. Upon removal of the sample from the subsurface, the soil sample was removed from the acetate sleeve and placed on an examination stand.

The soil sample was field screened for organic contaminants on 2-foot intervals using a photoionization detector (PID) equipped with an 11.6 electron-volt (eV) lamp. The soil within each 2-foot interval with the highest PID reading was sampled for on-site GC analysis for PCE, TCE, and cis-1,2-DCE. Laboratory confirmation samples were not collected. The results of this assessment are reported in Section 4.

Once sampled, the soil was described on a drilling log (Appendix F) per the IWFSP, Appendix B, Section 7.0 (MP-BMcD, 2004a). Following completion of each description, the soil was stored in a UN approved drum and transported to the landfarm treatment cell for treatment following treatment cell revitalization.

3.9 TREATABILITY BENCH STUDIES

Natural organic matter (NOM) and reduced metal species in the subsurface can exert a significant oxidant demand that competes with the contaminants of concern for the available permanganate (MnO_4^-), and may directly affect MnO_4^- persistence and transport in the subsurface, possibly resulting in incomplete chemical oxidation of the target compound(s). This natural demand for the oxidant must be satisfied before the oxidant can effectively react with and degrade all of the targeted compounds. Therefore, a NOD kinetic study was performed on subsurface soil samples collected from the treatment area to determine the amount of MnO_4^- necessary to satisfy the NOD. A VOC destruction study was also performed on the soil samples to confirm that the amount of MnO_4^- necessary to satisfy the NOD is also capable of destroying the targeted VOCs. The results of both of these studies are presented in Section 4. This phase of the field work was conducted by Carus with BMcD oversight. Groundwater collected from the treatment area was used in the NOD kinetic and VOC destruction studies to provide a reactant that is representative of site conditions.

The treatability bench studies for chemical oxidation of the contaminants of concern in AOC 3 was conducted on soil samples collected from the subsurface adjacent to Monitoring Well DCF02-42. Soil samples were collected from the vadose and saturated zones in this area. For the vadose zone, representative soil samples were collected from each different soil type encountered between the bottom of the high pressure gas line and the groundwater table as defined during the vadose zone assessment. A single soil sample was collected from the saturated zone. Each soil sample was used to determine the NOD kinetics and VOC destruction efficiency for the corresponding soil type. A groundwater sample was collected from the saturated zone in AOC 3 for use during the treatability bench studies for each soil type.

The NOD of the soils in AOC 3 was estimated by performing 10-day NOD kinetic studies on individual soil samples collected from the vadose and saturated zones. A VOC destruction study was performed concurrently with each NOD kinetic study over the 10 day period. A treatability bench test including NOD kinetics and VOC destruction was performed on a single soil sample collected from the saturated zone and one soil sample from each soil type encountered in the vadose zone.

The results from the NOD kinetics and VOC destruction studies were used to determine the mass of MnO_4^- required for complete in-situ chemical oxidation of the targeted VOCs in the vadose and saturated zones. At most sites, the NOD of the soil is several orders of magnitude greater than the demand expressed by the contaminants of concern. The mass of MnO_4^- required to satisfy the contaminant demand was determined based on an assessment of the contaminant mass and phase distribution as well as the MnO_4^-/contaminant stoichiometric relationships.

During the NOD kinetics study, the evaluation of MnO_4^- consumption was conducted by monitoring the decay of MnO_4^-, thus allowing for a direct determination of the NOD on a mass/mass basis (grams [g] MnO_4^-/kilogram [kg] soil). During the VOC destruction study, the evaluation of contaminant destruction was conducted by analyzing samples for VOCs prior to and following the reaction to determine destruction efficiency. Data generated from these experiments was used to determine the approximate volume of MnO_4^- required to treat the contaminants of concern, as well as overcoming the NOD presented by the native soils.

3.9.1 Bench Study Soil Sample Collection

Soil samples collected for the treatability bench studies were collected using direct-push equipment following completion of the utility clearance. Soil samples were collected from the vadose zone and from the saturated zone near Monitoring Well DCF 02-42. This phase of the field work was conducted by EPS with BMcD oversight.

3.9.1.1 Vadose Zone Soil Sample Collection

For the vadose zone near Monitoring Well DCF02-42, a soil sample was collected for each different soil type below the base of the high pressure gas line using direct-push technology. The soil samples were collected above the groundwater surface using a 4-ft macro-core (2-inch diameter) soil sampler with acetate liners from the locations identified on Figure 3-2. The soil samples were collected on November 16, 2006. Multiple borings were required to collect the four pounds of soil per sample required for testing. The soil sample intervals were based on the soil description detailed on the boring log completed during the earlier vadose zone assessment for Boring TS-1. Therefore, the treatability sample depths were co-located with the soil types encountered in the vadose zone assessment Boring TS-1. Soil samples were collected from three distinct intervals that represented a clay soil type (4-8 ft bgs), a silt type soil (12-16 ft bgs), and a silty sand type soil (20-24 ft bgs). Each distinct interval that was sampled was described on a single combined boring log for multiple offsets (Boring Log TS-1a, Appendix F).

Each vadose zone soil sample was removed from the macrocore sampler and placed in a resealable one-gallon plastic bag. The samples were double bagged and a sampling label was placed between the inner and outer bags indicating the boring number, sample depth, sample time, and date of collection. This information was also placed on a chain-of-custody (COC). The sample was then placed in an appropriate shipping container containing ice and was shipped by overnight courier to Carus Chemical Company.

Following completion of soil sampling activities, excess soil was stored in a UN approved drum and transported to the landfarm treatment cell for treatment following treatment cell revitalization.

3.9.1.2 Saturated Zone Soil Sample Collection

For the saturated zone in AOC 3, a single soil sample was collected below the groundwater surface using a 4-ft macro-core (2-inch diameter) soil sampler equipped with a sand catcher and an acetate liner at the location identified on Figure 3-2. The saturated soil sample was collected on November 16, 2006. The soil sampling interval was determined based on the saturated zone soil interval identified during the vadose zone assessment. Once the depth to groundwater was established, the boring was advanced to a point below the water table interface and a saturated soil sample was removed from the macrocore sampler and placed into a resealable one-gallon plastic bag.

The sample was double bagged and a sampling label was placed between the inner and outer bags indicating the boring number, sample depth, sample time, and date of collection. This information was also placed on a COC. The sample was placed in an appropriate shipping container containing ice and was shipped by overnight courier to Carus Chemical Company.

Following completion of soil sampling activities, excess soil was stored in a UN approved drum and transported to the landfarm treatment cell for treatment following treatment cell revitalization.

3.9.2 Bench Study Groundwater Sample Collection

A representative groundwater sample was also collected from the saturated zone in AOC 3. A groundwater sample was collected from Monitoring Well DCF06-25 following purging of six gallons of groundwater. This volume represents twice the volume removed during the previous groundwater sampling event conducted in September 2005. The groundwater sample was collected in 22 nonpreserved 1-liter amber jars. A sampling label was placed on each container indicating the monitoring well number, sample time, and date of collection. This information was also placed on a COC. A label was taped to the container and each container was then placed in protective bubble wrap and immediately placed in a cooler containing ice and was shipped by overnight courier to Carus Chemical Company.

Liquid IDW generated during sampling procedures was collected and stored in a UN-approved drum. Following completion of vadose assessment activities, the purge water was transferred to the holding tank at the landfarm treatment cell for storage.

3.9.3 Natural Oxidant Demand Kinetic Study

The NOD kinetic study was conducted by Carus Chemical Company. The objectives of the NOD kinetic study were to determine the NOD of the subsurface soil in AOC 3 and the rate of natural oxidant consumption. Each reaction vessel was filled with 50g of soil from either the vadose zone or the saturated zone, 100 milliliters (ml) of groundwater from the Site, and permanganate dosing solution. To meet the study's objectives, each study was performed using low, medium, and high oxidant concentrations.

At the start of each experimental run, 10 ml of concentrated oxidant solution was introduced into three separate reaction vessels containing soil and groundwater at MnO_4^- dosages equivalent to approximately 3, 15, and 30 g MnO_4^- per 1 kg soil (corresponding to low, medium, and high dosages, respectively). Following oxidant introduction, the reaction vessels were inverted three times to mix the reactor. This mixing was performed twice each day. The supernatant liquid in each vessel was sampled for MnO_4^- concentration for distinct time periods (e.g. 1, 3, 7, 24, 48, etc. hours) for a maximum period of 10 days. Full oxidant consumption (or reduction of the oxidant consumption rate to essentially zero) may not be completed for weeks, thus the 10-day NOD was used as a reasonable approximation of the oxidant demand for site-specific soils.

The oxidant demand was calculated by subtracting the residual MnO_4^- mass from the mass of MnO_4^- added to the reactor, and divided by the mass of soil reacted, to provide a demand with units of g of MnO_4^- consumed per kg of soil reacted. The mass of residual MnO_4^- was calculated as the concentration of MnO_4^- in the liquid divided by the volume of liquid in the reactor. Similarly, the mass of MnO_4^- initially introduced was calculated as the concentration of MnO_4^- in the added solution divided by the volume of solution added.

3.9.4 VOC Destruction Study

The NOD kinetic study was used to determine the amount of oxidant required to satisfy the NOD. However, it was also necessary to determine if the MnO_4^- dosage required to satisfy the NOD was also capable of destroying the VOCs present in the soil and groundwater. The VOC destruction study was performed to indicate if VOCs are destroyed more quickly or more slowly than the oxidant is consumed by the soil. The VOC destruction study was conducted by Carus Chemical Company.

Each VOC destruction study was performed using the three MnO_4^- dosages from the NOD kinetics study (3, 15, and 30 g MnO_4^- per 1 kg soil), plus one control sample (no MnO_4^- dosage). Each reaction vessel was filled with approximately 90 g of contaminated soil and 900 ml of site groundwater. A 10-ml aliquot of MnO_4^- solution (with concentration adjusted to correspond to the oxidant demand as described above) was added to each reactor, with the exception of the control. The control reactor received 10 ml of deionized water.

Prior to the start of the test, a soil and groundwater sample was collected from the portion used in the control and analyzed for VOCs. Each reaction vessel was mixed twice daily. All three vessels dosed with MnO_4^- were allowed to react until the MnO_4^- was consumed for a period of 10 days. At the conclusion of the test, the soil and groundwater from each reactor (3 dosed with MnO_4^- plus 1 control) was analyzed for PCE, TCE, DCE, and VC concentrations.

The VOC concentrations in the soil and groundwater phases from each reactor were used to construct a mass balance. The phase distribution (mass of VOCs in the groundwater and soil) was used to evaluate desorption for oxidation. The VOC mass in the oxidized samples was compared with the mass in the control sample to determine overall oxidation efficiency. The results were used to determine if the selected dosages were sufficient for VOC oxidation, or if additional experiments were necessary to determine the appropriate oxidant dosage.

The data collected during the treatability bench studies was analyzed to determine the rate of oxidant consumption and amount of oxidant required to facilitate complete destruction of the contaminants of concern in the soil and groundwater at AOC 3. This information was then used to determine the oxidant-loading rates for the vadose zone and saturated zone chemical oxidation applications.

3.10 LANDFARM TREATMENT CELL REVITALIZATION

An existing landfarm treatment cell was located at Camp Funston (see Figure 2-2) immediately west of the Environmental Waste Management Center (EWMC). The landfarm had been constructed for treatment of soils from the 354 Area Solvent Detections Site. This treatment cell was revitalized prior to treating of the excavated soils from the DCF pilot study, because the liner was compromised following completion of the 354 Area Solvent Detections Site pilot study and was removed at the conclusion of that pilot study.

The landfarm treatment cell was revitalized from November 14 through November 18th, 2005. The size of the treatment cell was 135 ft by 270 ft (see Figure 3-3). A four ft high berm was constructed around the perimeter of the cell. The liner consisted of 30-mil high density polyethylene (HDPE) which was delivered in rolls 25 ft wide and 1,000 ft long and was manufactured by Poly-Flex, Inc. The liner was specifically designed for containment of hazardous waste and is resistant to ultraviolet light for surface applications. The seams of the HDPE sheeting were welded to preclude leakage from the treatment cell. The liner covered the entire cell and overlapped the berm that surrounded the cell. A sump was constructed in the northeast corner of the cell to collect any runoff and/or leachate from the treatment cell. This sump was also lined with HDPE sheeting. Upon completion of the liner installation, a visual inspection was conducted to insure that the integrity of the liner was not compromised during installation.

Following installation of the liner, sand was transported to the treatment cell and was spread across the cell to a uniform depth of six inches. The sand protected the liner from damage during the disking of the excavated soil. A sump tank was also located adjacent to the sump pit and was used to collect runoff and/or leachate that had accumulated in the sump during soil treatment. The leachate was pumped from the sump into the sump tank for temporary storage prior to disposal.

Following revitalization of the landfarm treatment cell, soils excavated from Area #1 and Area #2 of AOC 1 as well as soil removed during excavation activities in the utility corridor were transported to the cell for treatment. Following treatment, the soil was transported to the CD landfill for use as cover and the landfarm treatment cell was removed.

3.11 AOC 1 SOIL EXCAVATION, TRANSPORTATION, AND TREATMENT

3.11.1 Area #1 and Area #2 Excavation and Treatment

Shallow subsurface soil with PCE concentrations above the KDHE RSK soil to groundwater value for PCE of 180 µg/kg was excavated at AOC 1 and transported to the landfarm treatment cell for treatment. These excavations were conducted by Greenfield with BMcD oversight from November 21st through December 16, 2005. There were two main areas that were excavated; Area #1, which was centered on former Building 180; and Area #2, which was centered around MH 363 (Figure 3-4). Additional soil excavation areas in AOC 1 included selected sanitary sewer lines, the MH 367 area, and the AGL.

Before commencement of soil excavation, the areas to be excavated were surveyed by KAW and marked with white stakes and flags. Additionally, erosion/storm water control measures were implemented which included surface grading to remove low areas and hay bale sediment fences to control overland flow during precipitation events. Site preparation included establishing a personnel staging area, an equipment decontamination area, establishing access/egress corridors, and establishing site security by placing caution signs and fencing around the work area (Figure 3-4).

The soil was excavated using a John Deere 230c track hoe and a John Deere backhoe. Once excavated, the soil was loaded into lined dump trucks and transported to the landfarm treatment cell at Camp Funston. Each dump truck was covered during transport. Once the soil had been transported to the treatment cell, it was spread within the cell to a thickness of no greater than three ft (Section 3.12).

During excavation, selected soil samples were collected from the sidewalls and the bottom of each excavation for offsite 24-hour analysis of PCE, TCE, cis-1,2-DCE and VC. These samples were collected from the middle of the track hoe/backhoe bucket to remove the necessity for field personnel to enter the excavation. The samples were collected to confirm that remaining soil concentrations were below the KDHE RSK soil to groundwater value of 180 μg/kg for PCE, 200 μg/kg for TCE, 800 μg/kg for cis-1,2-DCE, and 20 μg/kg for VC.

A work zone was set up around the perimeter of each excavation. The work zone was defined by the use of barricades combined with yellow caution tape and orange cones. A temporary fence was set up at the end of each working day to cordon off the work zone. Signs were also posted around the work zone indicating that the area was off-limits to all non-essential and untrained personnel. During excavation activities, breathing space/work zone readings were collected using a combustible gas indicator at various monitoring locations at and around the excavation to ensure that the air in the work zone and around the perimeter was safe for field activities. Readings were recorded in the field log book along with time and location.

3.11.1.1 Soil Excavation - Area #1

Following the location of all utilities in the proposed excavation area, soil excavation began at Area #1. Soil Area #1 was located in the central to southwestern portion of the former Building 180 footprint (Figure 3-4). In this area, all of the soils with PCE concentrations above the KDHE RSK soil to groundwater value of 180 μg/kg were concentrated in the upper shallow soil zone from 1 to 8 ft bgs (Table 2-1). Area #1 was divided into two treatment areas; Area 1 South and Area 1 North. The overall approximate size of both portions of the treatment area for Area #1 was 75 ft by 125 ft. For both areas, the upper eight feet of soil was excavated which amounted to 1,900 cubic yards (yd^3).

3.11.1.2 Soil Excavation - Area #2

Area #2 was located around former MH 363 (Figure 3-4). In this area, all of the soil with PCE concentrations above the KDHE RSK soil to groundwater value of 180 µg/kg was concentrated in the upper shallow soil from 1 to 12 ft bgs (see Table 2-1). The size of the treatment area for Area #2 was irregular based on topographic constraints (Tributary A and the eastern tree line), but was approximately 52 ft by 43 ft. Area 2 was also subdivided into two treatment areas based on the depth of contamination. In the northern portion of the Area 2 treatment area, the soil was excavated to a depth of eight feet. This area was 28 ft by 43 ft by 8 ft for an estimated volume of 360 yd^3. In the southern portion of the Area 2 treatment area, the soil was excavated to a depth of 12 ft. This area was 24 ft by 13 ft by 12 ft for an estimated volume of 140 yd^3. Soil was also removed around MH 363. This area was 30 ft by 15 ft by 18 ft for an estimated volume of 300 yd^3. The total soil removed from the Area 2 treatment area was approximately 800 yd^3.

3.11.1.3 Confirmation Soil Sample Collection for Area #1 and Area #2

Once the maximum depth of each excavation had been reached, laboratory confirmation samples were collected. Samples were collected from each sidewall and from the bottom of the excavation for each area. These confirmation soil samples were analyzed for PCE, TCE, cis-1,2-DCE, and VC using USEPA Method 8260B. One duplicate sample and a single matrix spike/matrix spike duplicate (MS/MSD) sample were also collected from each area. Soil samples were submitted to CAS of Salina, Kansas. Additionally, to confirm that hazardous constituents do not exist in the excavated soil and that the soil was not being improperly transported from the site to the landfarm treatment cell, one soil sample was collected from both Area #1 and Area #2 and analyzed for VOCs using USEPA Methods 1311/8260 for toxicity characteristic leaching procedure (TCLP). Based on previous soil sample results for this area, the TCLP sample was collected from the 1-4 ft depth (see Table 2-1) at Area #1 and from the 4-8 ft depth at Area #2. The confirmation soil sample results are presented in Section 4.

3.11.1.4 Confirmation Soil Quality Assurance/Quality Control Procedures for Area #1 and Area #2

One set of quality assurance (QA) and quality control (QC) soil samples were collected during confirmation soil sampling for both Area # 1 and Area #2. One duplicate sample (QC) was collected and sent to CAS for analysis. One QA sample (split sample of the duplicate) was submitted to the USACE Chemical Quality Assurance Branch of Waterways Experiment Station in Omaha, Nebraska (QA Lab).

3.11.1.5 Backfilling of Excavations for Area #1 and Area #2

Following excavation, borrow material of a high clay content was obtained from the designated borrow area on Campbell Hill and placed into the excavations. The borrow soil was compacted in the excavation and the excavated areas were returned to their original condition. The clay was compacted in 1-ft lifts from the bottom of the excavation to the ground surface. A slight mound was placed on the excavation areas to account for settling. Following backfilling, Greenfield added topsoil and re-seeded the area with a standard Natural Resource Conservation Service (NRCS) native grass mix.

3.11.2 Utility Corridor Excavation and Treatment

The utility corridor excavation and treatment was undertaken because it was suspected that the utility corridor served as a conduit for contaminant transport of dry cleaning process waste water that leaked from the sanitary sewers. This portion of the excavations focused on the AGL, the sanitary sewer line, MH 363, and MH 367. Following soil excavation at Area #1 and Area #2, selected portions of the utility corridor running parallel to Custer Road from MH 363 westward was exposed to confirm the presence or absence of chlorinated solvent contamination within this corridor (Figure 3-4). Samples were collected from the AGL bedding material and analyzed on-site with a field GC. Several exploratory trenches were also excavated to determine the location of the AGL. The area around Monitoring Well DCF02-42 was not exposed because the KGS removed the AGL in this area and replaced it with the new high-pressure gas line. Excavations were also conducted to expose MH 363 and to locate the sewer line connected to MH 367. These portions of the field activities were completed by Greenfield and EPS with BMcD oversight. The utility corridor field work was completed in two stages: excavation and treatment.

3.11.2.1 Stage 1 - Excavation

The first stage involved the removal of soil covering portions of the sanitary sewerline; MH 363, MH 367, and the AGL (see Figures 3-4 through 3-7). Because the soil removal was in close proximity to buried utility lines, manual excavation was required in several areas, particularly along the storm water catch basin and north of MH 363. The majority of the excavation work was conducted using a backhoe. All soil that was excavated was field screened using a PID. Soils that presented detections above 1 ppm during field screening was removed and transported to the landfarm treatment cell. Soil with detections below 1 ppm was stockpiled on site and returned to the trench as backfill. Several waste pile samples were also collected and analyzed on-site with a field GC to confirm field screening results less than one ppm. The results of the on-site waste pile sampling are presented in Section 4.

Soil around MH 363, MH 367, and from the sewer line leading from MH 363 to MH 365 was excavated as part of the pilot study. Soil was excavated from around the southern end of MH 367 to a depth of six feet to uncover the entrance to the sanitary sewer line leading from MH 367 to MH 365 (Figure 3-5). Soil was removed from around MH 363 to a depth of nine feet to uncover the sanitary sewer line leading from MH 363 to MH 365 and to a depth of 18 feet to the base of the MH 363 around the southern and western portions of the MH (see Figure 3-6). Soil was also excavated to a depth of nine feet to uncover the sewer line connecting MH 363 to 365. The sewer line was uncovered in a north-trending direction for approximately 66 feet from the MH 363 excavation to the active high pressure gas line (Figure 3-6). The soil was removed from around MH 363 and portions of the sewer line connecting MH 365 to 363 because these areas were suspected source areas based on information obtained during previous investigations.

For the sewer line connecting MH 363 to 365, soil samples were collected every five feet from the bedding material and analyzed on-site using a field GC for PCE, TCE, and cis-1,2-DCE (Figure 3-6). The soil samples were collected from the pipeline bedding material surrounding the pipe and were not composited. The soil samples were collected starting at the northern portion of the MH 363 excavation to the sewer line treatment access hole (Figure 3-6). Soil samples were not collected north of the treatment access hole due to proximity to marked utilities. At each sample location, a grab soil sample was collected for field and potential laboratory analyses. The field sample was analyzed immediately on site and the laboratory sample was placed in a cooler containing ice. If field GC analysis indicated that chlorinated solvents were not detected, the soil sample collected at that location was discarded. If chlorinated solvents were detected in the sample, then the Fort Riley and the USACE project manager were notified and, based on consultation, selected soil samples were sent to CAS for analytical confirmation for the same analytes. The results of the utility corridor excavation sampling are presented in Section 4.

Two exploratory trenches were excavated based on KGS utility line locations (see Figure 3-4). The western exploratory trench was 35 feet in length and five feet deep. This trench uncovered an active gas line that formerly fed former Building 184 and an active 12-inch water main. Because the AGL was not located in this area, the trench was backfilled. The eastern exploratory trench was 50 feet in length and three feet deep. This trench followed a four-inch vitreous clay tile (VCT) sewer line until it connected to the main eight-inch sewer line (Figure 3-7). The eight-inch sewer line was excavated until it ran beneath the AGL. The AGL was then excavated in an eastward direction to 10 feet beyond the storm sewer catch basin at an average depth of three feet.

When the AGL and the sanitary sewer line were exposed, the bedding material within the utility trench including a portion of the sanitary sewer line and the AGL was sampled on 10 ft horizontal intervals along the length of the corridor and analyzed on site using a field GC for PCE, TCE, and cis-1,2-DCE

(Figure 3-7). The soil samples were collected from the pipeline bedding material surrounding the pipe and were not composited. At each sample location, a grab soil sample was collected for field and potential laboratory analyses. The field sample was analyzed immediately on site and the laboratory sample was placed in a cooler containing ice. If field GC analysis indicated that chlorinated solvents were not detected, the soil sample collected at that location was discarded. If chlorinated solvents were detected in the sample, then the Fort Riley and the USACE project manager were notified and, based on consultation, selected soil samples were sent to CAS for analytical confirmation for the same analytes. The results of the AGL and sanitary sewer line utility corridor excavation sampling are presented in Section 4.

The amount of HAGL and sewer line exposed was determined based on the results of the field GC analyses. The HAGL and sewer line exposed was based on the following criteria:

- If no detections were recorded from samples collected from the bedding material, the USACE and DPE project managers were notified immediately prior to cessation of corridor excavation in that direction.
- If detections were recorded, then pipeline excavations continued until terminated based on site physical constraints (utilities or Custer Road).

For the western portion of the AGL/sanitary sewer line trench at the point where the AGL crosses over the sanitary sewer line (Figure 3-7), the soil analyzed on the field GC were non-detect (ND) for PCE, TCE, cis-1,2-DCE, and VC (see Results-Section 4), therefore, westward excavation of the AGL was not conducted. For the eastern portion of the AGL beyond the storm sewer catch basin, excavation was continued for approximately 10 feet before additional utilities were encountered (Figure 3-7). Eastward excavation of the AGL was abandoned at this point after consultation with the Fort Riley Project Manager.

3.11.2.2 Confirmation Soil Sample Collection

One confirmation soil sample (QC) was collected for every 10 samples analyzed using the field GC. The total number of samples collected in the field was based on the actual amount of pipeline uncovered. For every 10 confirmation samples collected, one sample was collected for QA. For every 20 samples collected and analyzed using the field GC, one sample was collected for a MS/MSD. The soil samples were submitted to CAS and analyzed for PCE, TCE, cis-1,2-DCE, and VC in accordance with USEPA Method 8260B. The QA samples were submitted to the USACE laboratory in Omaha, Nebraska.

3.11.2.3 Stage 2 – Treatment and Backfilling

The second stage of the utility corridor excavation activities consisted of the application of a 10% (by weight) aqueous $NaMnO_4$ oxidant solution to the excavation prior to backfilling (Figures 3-4 through 3-7). The aqueous $NaMnO_4$ oxidant solution was applied into the sanitary sewer line connecting MH 367 to 365, into the sanitary sewer line connecting MH 365 to MH 363, into the excavated area around MH 363, within MH 363, and in selected portions of the AGL trench based on on-site GC results.
The oxidant solution was applied to these treatment areas by gravity feeding through a hose attached to a mixing tank. The 10% $NaMnO_4$ solution was created in the mixing tank by combining 40% $NaMnO_4$, obtained from Carus Chemical Company with water obtained from the designated non-chlorinated water hydrant. The flow rate of the solution into the trench and the movement of the delivery hose along the trench was regulated to allow for one cubic foot (7.5 gallons) of solution per linear foot of trench. A totalizing flow meter was used to monitor the oxidant flow rate and cumulative volume. This portion of the field activities was handled by BMcD.

Once the bedding material had been treated, borrow material was transported from the Campbell Hill borrow area to the site where it was used to backfill the open excavations on the day following treatment. The backfill was placed in the excavation and compacted in one foot lifts from the bottom of the excavation to the ground surface. A slight mound was placed on the excavation to account for settling. Following compaction, the area was returned to its original condition. The excavation subcontractor placed top soil over the excavated areas and then re-seeded the area with a standard NRCS native grass mix. This portion of the field activities was be handled by Greenfield with BMcD oversight.

3.11.2.3.1 Sanitary Sewer Line and MH 363 Chemical Oxidation Application

Following soil sampling of the bedding material adjacent to the sanitary sewer line that connected MH 365 to 363, an aqueous $NaMnO_4$ treatment was applied to the abandoned sanitary sewer line connecting MH 363 to MH 365, to MH 363, and to the sewer line bedding material between MH 363 and 365 (Figure 3-6). $NaMnO_4$ was applied to the abandoned sanitary sewer line and MH 363 to treat any contaminant residue remaining within the line and the MH, and to address the surrounding soil areas adjacent to sewer line cracks and offsets. During application of $NaMnO_4$ to the sanitary sewer line, a chemical feed line was inserted into an opening in the casing and the feed line was extended northward eight feet toward MH 365. Once the feed line was in place, $NaMnO_4$ was gravity fed into the line. Once the sewer line was full, MH 363 was also treated with $NaMnO_4$. Approximately 260 gallons of $NaMnO_4$ were applied to the sanitary sewer line and MH 363. Once the line and MH had been treated, approximately 235 gallons of $NaMnO_4$ was applied to the sanitary sewer line excavation. The soil surrounding MH 363 to the west and south was excavated to approximately 18 feet bgs. This excavation reached the base of the MH. The MH

363 excavation was also treated with approximately 497 gallons of $NaMnO_4$. This portion of the field activities was handled by BMcD. Following treatment, the excavations were backfilled. This portion of the field activities was handled by Greenfield with BMcD oversight.

3.11.2.3.2 MH 367 Chemical Oxidation Application

Once the general location of MH 367 was determined based on the magnetometer survey, the area was excavated using a backhoe (Figure 3-5). This portion of the field activities was handled by Greenfield with BMcD oversight. Following excavation, an aqueous $NaMnO_4$ treatment was applied into the abandoned sanitary sewer line that formerly connected MH 367 to MH 365. $NaMnO_4$ was applied to the abandoned sanitary sewer line to treat any contaminant residue remaining within the line and the MHs and to treat the soil surrounding the sewer line cracks and offsets. During application of $NaMnO_4$ to the sanitary sewer line, a chemical feed line was inserted into an opening in the casing and the feed line was extended southward toward MH 365. Once the feed line was in place, $NaMnO_4$ was gravity fed into the line. Approximately 1,460 gallons of $NaMnO_4$ was applied to the sanitary sewer line between MH 367 and 365. This portion of the field activities were handled by BMcD. Following treatment, the excavation was backfilled. This portion of the field activities was be handled by Greenfield with BMcD oversight.

3.11.2.3.3 AGL Chemical Oxidation Application

Following soil sampling of the AGL bedding material, an aqueous $NaMnO_4$ treatment was applied to the AGL (see Figure 3-7). $NaMnO_4$ was applied to the entire length of the excavated AGL corridor (85 ft). Based of field GC results, only the AGL corridor was treated. During application of $NaMnO_4$ to the sanitary sewer line, a chemical feed line was placed at multiple locations along the AGL corridor and $NaMnO_4$ was gravity fed into the excavation. Approximately 1,000 gallons of $NaMnO_4$ was applied to the AGL corridor. This portion of the field activities was handled by BMcD. Following treatment, the excavation was backfilled. This portion of the field activities was be handled by Greenfield with BMcD oversight.

3.12 SOIL TREATMENT AT THE LANDFARM TREATMENT CELL

3.12.1 Soil Treatment

The landfarm treatment cell contained soil excavated from the AOC 1 area which included soil from Area #1 North, Area #1 South, Area #2, the sanitary sewer line, the AGL, and the MH excavations (Figure 3-4). Due to time constraints in regards to the new building construction at Camp Funston, the total volume of soil removed from AOC 1 was stored at the landfarm treatment cell at one time. For soil treatment at the landfarm treatment cell (see Figure 3-3), the soil was tilled using 18-inch disks attached to a farm tractor. The tractor pulled the disk array across the soil to lift, turn over, and aerate the soil to increase soil volatilization. The soil was disked twice each week during treatment to improve the volatilization of chlorinated solvents. Each tilling cycle was conducted for approximately three weeks. The top 18-inches of soil were tilled first. Following tilling, confirmation samples were collected from the top 12-inches (Figure 3-8). This spacing allowed for a six-inch safety overlap between the tilling depth and the sample depth. The six-inch depth difference also allowed for a treatment overlap on the following tilling treatment cycle. This portion of the field activities was handled by Greenfield with BMcD oversight.

Following receipt of soil analytical results verifying that the soil concentrations in the treatment cell were below the KDHE RSK for PCE, TCE, and cis-1,2-DCE, and VC, the treatment cell was divided into approximately 20 by 20 ft sections and only the top 12-inches of soil was removed. The 12-inch removal depth was verified by on-site personnel. This treatment process was repeated twice. The third tilling cycle only required a 12-inch tilling depth. The disking was a one-day operation in each case. Precautions were taken by the contractor to ensure that excessive dust was controlled by tilling on calm and slightly windy days. The contractor also used these opportunities to conduct routine inspection and maintenance of the treatment cell and to check on the level of leachate in the holding tank.

3.12.2 Confirmation Soil Sampling

The purpose of the confirmation soil sampling was to evaluate the effectiveness of the land farming and to confirm that the soil in the treatment cell was below the target concentrations for PCE, TCE, cis-1,2-DCE, and VC of 180, 200, 800, and 20 µg/kg, respectively, following treatment. These are the KDHE RSK standards for the soil to groundwater protection pathway (residential scenario). This portion of the field activities was handled by BMcD personnel.

Confirmation soil samples were collected from the landfarm treatment cell following three separate treatment cycles. For each treatment cycle, the confirmation soil samples were collected following approximately three weeks of treatment. Twelve confirmation soil samples were collected for each phase (Figure 3-8). The FSM established a 12 point sampling grid with a measuring tape and designated locations for the collection of these soil samples. Each sample was collected from a depth of 12 inches below the surface and was not composited. Two duplicate samples and a single MS/MSD sample were also collected for each treatment phase. The soil samples were submitted to CAS and analyzed for PCE, TCE, cis-1,2-DCE and VC in accordance with USEPA Method 8260B. All confirmation samples were analyzed on a 24-hour turn-around schedule due to the Camp Funston time constraints. The results of the landfarm treatment cell confirmation sampling are presented in Section 4.

3.16.4 Pre- and Post-Injection Performance Monitoring

Following the completion of oxidant injection activities in the saturated zone at AOC-3, post-injection activities, including field monitoring and groundwater sampling, were conducted. Field monitoring activities were performed to evaluate the migration and persistence of the oxidant in the subsurface. Pre- and post-injection monitoring was conducted at Monitoring Well DCF02-42, Monitoring Well DCF06-25, and Piezometer PSPZ-1. Pre-performance monitoring was conducted during the March 2006 groundwater sampling event. The results for this event are presented in Section 4. The post-injection performance monitoring was conducted from May 19, 2006 through August 2007. Parameters measured during pre/post performance monitoring included visual observation for the presence of MnO_4^- and manganese dioxide, and field measurements for ORP and pH. If the MnO_4^- was detected in the well, then ORP and pH data were not collected. This portion of the field activities was handled by BMcD.

3.17 AOC 2 AND OTHER AREAS EAB APPLICATION

3.17.1 General

CAP18™, a non-emulsified (or neat) vegetable oil product, was applied to enhance the natural degradation of the chlorinated VOCs in groundwater at AOC 2 (Figure 3-12), near Monitoring Well DCF02-49c on the Island, and near Monitoring Wells DCF99-37c and B354 99-11c near the Horse Corral (see Figure 3-13). Vegetable oils have gained wide acceptance for groundwater remediation over the past few years. CAP18™ was selected because the neat oil is more likely to remain within the treatment area under the potentially high flow conditions that exist at AOC 2 and the flow and natural attenuation conditions that presently exist at the Island and the Horse Corral. This portion of the field activities was handled by EPS with BMcD oversight.

3.17.2 AOC 2

3.17.2.1 EAB Application

The groundwater treatment area is located within the bedrock erosional channel that underlies the eastern portion of former Building 180 (Figure 1-2). Monitoring wells installed in this channel include Monitoring Wells DCF92-05, DCF93-13, DCF06-40, and DCF02-41. Based on analytical data collected from these monitoring wells, as the groundwater flows down the axis of the channel toward the Kansas River, the chlorinated solvent contamination is naturally attenuated. To increase the effectiveness of the natural attenuation in the bedrock erosional channel and reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSKs and MCLs of 5 µg/L for PCE and TCE as well as to decrease the monitoring time for this AOC, a pilot study involving the injection of CAP18™ down the axis of the bedrock erosional channel north of the UPRR tracks was conducted. Implementation of EAB in AOC 2 followed the removal of shallow contaminated soil in AOC 1. The size of the treatment area was approximately 70 ft by 230 ft. This treatment area encompasses groundwater that exhibited PCE detections that exceeded the USEPA MCLs and KDHE RSK standards for PCE and TCE for the groundwater pathway.

3.17.2.2 EAB Dosage

For VOC data, the highest concentration detected in the AOC 2 monitoring wells for each of the target VOCs was used in the CAP18™ demand calculation (see Table A-1, *Quality Control Summary Report for the Spring 2006 Groundwater Sampling Event,* BMcD, 2006a). For dissolved oxygen (DO) and nitrate, an average of the concentrations recorded in the monitoring wells was used in the demand calculation. Since no groundwater data for manganese was available, a default concentration of 10 mg/L was used in the demand calculation. The sulfate and ferrous iron concentrations for the demand calculation were estimated by averaging the concentrations recorded in the monitoring wells. Hardness was estimated using alkalinity (as calcium carbonate) concentrations. An average of the alkalinity concentrations recorded in the monitoring wells was used in the CAP18™ demand calculation.

CAP18™ was applied in an area that incorporated the MH 363 area and the former Building 180 foot print area (see Figures 2-4 and 3-12). CAP18™ treatment was applied from May 9, 2006 through May 18, 2006. The treatment zone extended from the water table at approximately 35 ft bgs to the bedrock surface at approximately 43 ft bgs. The water table treatment zone varied in thickness from approximately one to seven ft. The soil type in this treatment zone consisted of sand with minor amounts of clay. CAP18™ was applied through direct-push rods at two to three ft intervals at 73 locations on 18 feet centers. The amount of CAP18™ applied to the treatment area was approximately 8,200 pounds or approximately 1077 gallons at 7.66 pounds of CAP18™ per gallon. The total dosage was divided among the 72 injection points (Table 3-5). The treatment dose varied per location due to bedrock refusal, permeability, and daylighting issues. At several locations, the location was offset at different intervals due to subsurface obstructions. In general, the target dose for each location was between 15 and 20 gallons per point spread between three injection intervals. This amounted to approximately 115 to 154 pounds of CAP18™ per location or approximately 16 to 22 pounds of CAP18™ per vertical foot of the treatment interval.

Injection was accomplished at each injection location through direct-push rods using an injection pump and delivery hose. CAP18™ was fed by gravity to the injection pump. The injection pump was connected to direct-push rods using a high-pressure hose and the rods were equipped with an injection probe tip. Injection at each location was accomplished using a "top-down" direct-push injection method. This portion of the field activities was handled by EPS with BMcD oversight.

3.17.2.3 EAB Pre- and Post-Performance Monitoring

The performance monitoring program consisted of groundwater parameter monitoring at monitoring wells DCF92-05, DCF06-40, DCF93-13, and DCF02-41 (Figure 1-2). Pre-performance monitoring was conducted during the March 2006 groundwater sampling event. The results for this event are presented in Section 4. Post-performance EAB instrument monitoring was conducted from July through August 2007 and included instrument only monitoring, limited groundwater sampling from selected wells, and full monitoring well network sampling events.

Parameters that were measured during post-performance instrument monitoring included pH, DO, ORP, total iron, and ferrous iron (see Table 3-2). These parameters were measured using a low flow multi-channel meter, a flow cell, and dedicated bladder pumps. Groundwater was purged from each monitoring well using carbon dioxide carrier gas for several measurement cycles and performance parameters were recorded on Field Ground-Water Sampling Reports (Appendix G). Post-performance monitoring data was also collected during limited and full groundwater sampling events. Groundwater data collected during these events using a flow cell included redox-sensitive parameters such as pH, DO, ORP, total iron, and ferrous iron. Laboratory data included VOCs, nitrate, sulfate, methane, fatty acids derived from the CAP18™ (represented by total organic carbon), and non-hazardous breakdown products of the target VOCs (ethene and ethane). This portion of the field activities was handled by BMcD and an outside consultant responsible for the long term groundwater monitoring (LTM) at the DCF.

3.17.3 Monitoring Well DCF 02-49c

3.17.3.1 EAB Application

The groundwater treatment area is located slightly upgradient of Monitoring Well DCF02-49c (Figures 3-13 and 3-14). This monitoring well is located within 50 feet of the Kansas River. Although water samples previously collected by the USGS from the Kansas River have been ND for all VOCs, the analytical results from the Fall 2005 baseline groundwater sampling event for Monitoring Well DCF02-49c (Section 4, Table 4-1) indicated the presence of PCE, TCE, and cis-1,2-DCE in groundwater. PCE (26.3 μg/L) was the only compound detected above the MCL.

To stimulate natural attenuation in this area and reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSKs and MCLs of 5 μg/L for PCE as well as to decrease the monitoring time for this AOC; a pilot study involving the injection of CAP18™ upgradient of the

Monitoring Well DCF02-49c location was conducted. This work was conducted in September 2006 by EPS with BMcD oversight. Implementation of EAB at Monitoring Well DCF 02-49c followed injection activities at the AOC 2 area. The size of the treatment area was 100 ft by 15 ft in a northeast to southwest trend (see Figure 3-14).

3.17.3.2 EAB Dosage

The VOC and natural attenuation data for Monitoring Well DCF 02-49c was used in the CAP18™ demand calculation (see Table A-1, *Quality Control Summary Report for the March 2006 Groundwater Sampling Event,* BMcD, 2006a). This included the concentrations for sulfate, ferrous iron, nitrate, and DO. Because no groundwater data for manganese was available, a default concentration of 10 mg/L was used in the demand calculation. Hardness was estimated using alkalinity (as calcium carbonate) concentrations.

CAP18™ was applied in an area located upgradient of Monitoring Well DCF 02-49c. The treatment interval extended from the water table at approximately 13 feet bgs to the bedrock surface at approximately 40 feet bgs for an average treatment interval depth of 25 ft. The general soil type in the treatment interval was composed of deposits normally associated with river alluvium and consisted of sands and gravels at depth grading upward to clay and silts (fining upward sequence). CAP18™ was applied through direct-push rods at eight injection intervals at 11 locations on 10 feet centers in a zigzag pattern throughout the injection area (Figure 3-14).. The amount of CAP18™ applied to the treatment area was approximately 2,680 pounds or approximately 350 total gallons of CAP18™ (at 7.66 pounds of per gallon) (Table 3-6). The total dosage was divided among the 11 injection points at approximately 31 gallons (240 pounds of CAP18™ per point). The treatment dose varied per location due to thickness of treatment zone, permeability, and daylighting issues. In general, the target dose of 31 gallons per point was spread between eight injection intervals at approximately four gallons per interval. This amounted to approximately 10 pounds of CAP18™ per vertical ft of the 25 ft treatment interval.

Injection was accomplished at each injection location through direct-push rods using an injection pump and delivery hose. CAP18™ was fed by gravity to the injection pump. The injection pump was connected to direct-push rods using a high-pressure hose and the rods were equipped with an injection probe tip. Injection at each location was accomplished using a "top-down" direct-push injection method. This portion of the field activities was handled by EPS with BMcD oversight.

3.17.3.3 Pre- and Post-Performance Monitoring

The pre-injection performance monitoring program consisted of groundwater parameter monitoring at Monitoring Well DCF 02-49c during baseline groundwater sampling conducted in the March 2006 groundwater sampling event. Post-injection performance monitoring was conducted during the October 2006 and the spring 2007 full groundwater sampling events. Additional post-injection performance monitoring will be conducted during subsequent annual groundwater sampling events. Groundwater data collected during these events using a flow cell included redox-sensitive parameters such as pH, DO, ORP, total iron, and ferrous iron. Laboratory data included VOCs, nitrate, sulfate, methane, fatty acids derived from the CAP18™ (represented by total organic carbon), and non-hazardous breakdown products of the target VOCs (ethene and ethane). This portion of the field activities was handled by BMcD and an outside consultant responsible for the LTM at the DCF.

3.17.4 Monitoring Well DCF 99-37c and B354-99-11c

3.17.4.1 EAB Application

There are two groundwater treatment areas at the Horse Corral. The first area is located south of the sanitary sewer line at the northeast corner of the Horse Corral near Monitoring Well B354-99-11c (Figure 3-15). The analytical results from the Fall 2005 groundwater sampling event for Monitoring Well B354-99-11c (see Section 4, Table 4-1) indicated the presence of PCE, TCE, and cis-1,2-DCE concentrations in groundwater. PCE (11.2 µg/L) was the only compound detected above the MCL. The second area is located south of the sanitary sewer line and west of the Horse Corral near Monitoring Well DCF99-37c (see Figure 3-16). The analytical results from the Fall 2005 groundwater sampling event for Monitoring Well DCF99-37c (see Section 4, Table 4-1) indicated the presence of PCE, TCE, and cis-1,2-DCE. PCE (10.0 µg/L) was the only compound detected above the MCL.

To stimulate natural attenuation in these areas and reduce the groundwater chlorinated solvent concentrations to levels below the KDHE RSKs and MCLs of 5 µg/L for PCE as well as to decrease the monitoring time for the Horse Corral, a pilot study involving the injection of CAP18™ upgradient of these two locations was conducted in September 2006. This work was conducted by EPS with BMcD oversight. Implementation of EAB at the Horse Corral followed injection activities at the Monitoring Well DCF02-49c area. The size of each treatment area for Monitoring Well B354-99-11c and Monitoring Well DCF99-37c was each approximately 75 ft by 15 ft.

3.17.4.2 EAB Dosage

The VOC and natural attenuation data for Monitoring Wells DCF 99-37c and B354-99-11c were used in the CAP18™ demand calculation (see Table A-1, *Quality Control Summary Report for the March 2006*

Groundwater Sampling Event, BMcD, 2006a). This included the concentrations for sulfate, ferrous iron, nitrate, and DO. Because no groundwater data for manganese was available, a default concentration of 10 mg/L was used in the demand calculation. Hardness was estimated using alkalinity (as calcium carbonate) concentrations.

CAP18™ was applied to two 75-ft by 15-ft areas located upgradient of Monitoring Wells DCF 99-37c and B354-99-11c. For Monitoring Well DCF 99-37c, the treatment interval extended from the water table at approximately 27 ft bgs to the bedrock surface at approximately 47 ft bgs. For Monitoring Well B354-99-11c, the treatment interval extended from the water table at approximately 20 ft bgs to the bedrock surface at approximately 40 ft bgs. The treatment zone for both locations was approximately 20 ft thick. For both treatment areas, the soil type was composed of deposits normally associated with river alluvium and consisted of sands and gravels at depth grading upward to clay and silts.

For both treatment areas, CAP18™ was applied through direct-push rods at six injection intervals at 8 locations on 10 feet centers throughout each injection area. The amount of CAP18™ applied to the Monitoring Well DCF99-37c area was approximately 1,380 pounds or approximately 180 total gallons of CAP18™ (at 7.66 pounds per gallon). The amount of CAP18™ applied to the Monitoring Well B354-99-11c area was approximately 1,470 pounds or approximately 192 total gallons of CAP18™ (at 7.66 pounds per gallon). The total dosage for each area was divided among the 8 injection points (see Table 3-6) between 20 to 24 gallons per point. The treatment dose varied per location due to permeability and daylighting issues. In general, the target dose of 24 gallons per point (approximately 185 pounds CAP18™ per point) was spread between six injection intervals at approximately 4 gallons per interval. This amounted to 9 pounds of CAP18™ per vertical ft of the 20 ft treatment interval for each treatment area.

Injection was accomplished at each injection location through direct-push rods using an injection pump and delivery hose. CAP18™ was fed by gravity to the injection pump. The injection pump was connected to direct-push rods using a high-pressure hose and the rods were equipped with an injection probe tip. Injection at each location was accomplished using a "top-down" direct-push injection method. This portion of the field activities was handled by EPS with BMcD oversight.

3.17.4.3 Pre- and Post-Performance Monitoring

The pre-injection performance monitoring program consisted of groundwater parameter monitoring at Monitoring Well DCF99-37c and B354-99-11c during baseline groundwater sampling conducted in the March 2006 groundwater sampling event. Post-injection performance monitoring was conducted during the October 2006 and the spring 2007 full groundwater sampling events. Additional post-injection performance monitoring will be conducted during subsequent annual groundwater sampling events. Groundwater data collected during these events using a flow cell included redox-sensitive parameters such as pH, DO, ORP, total iron, and ferrous iron. Laboratory data included VOCs, nitrate, sulfate, methane, fatty acids derived from the CAP18™ (represented by total organic carbon), and non-hazardous breakdown products of the target VOCs (ethene and ethane). This portion of the field activities was handled by BMcD and an outside consultant responsible for the LTM at the DCF.

3.18 FALL 2006 FULL GROUNDWATER SAMPLING EVENT

A full groundwater sampling event was conducted in October 2006 to assess the performance of the remedial activities conducted at the AOCs and other areas. The sampling and analytical requirements for this event are presented in Table 3-3. All monitoring wells were purged and sampled based on the USACE Low Flow Protocol-Version 1.3 (USACE, 2002) with the exception of the manual inertial lift pump wells which were purged using a modified set of criteria. Analytical groundwater samples were not collected from monitoring well with MnO_4^-. All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS and QA samples were sent to the USACE laboratory in Omaha, Nebraska. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, Fall 2006 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2006b). The groundwater results for this sampling event are presented in Section 4.

3.19 JANUARY 2007 LIMITED GROUNDWATER SAMPLING EVENT

A limited groundwater sampling event was conducted in January 2007 to assess the performance of the remedial activities conducted at each AOC (excluding the Other Sites). Monitoring Wells sampled during this event included Monitoring Well DCF92-05, DCF93-13, DCF02-41, DCF02-44c, DCF02-49c, DCF06-40, and B354-99-11c. Analytical groundwater samples were not collected from monitoring wells with MnO_4^- which included Monitoring Wells DCF02-42, DCF06-25, and Piezometer PSPZ-1. The sampling and analytical requirements for this event are presented in Table 3-3. All monitoring wells were purged and sampled based on the USACE Low Flow Protocol-Version 1.3 (USACE, 2002). All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, January 2007 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2007). The groundwater results for this sampling event are presented in Section 4.

3.20 APRIL 2007 FULL GROUNDWATER SAMPLING EVENT

A full groundwater sampling event was also conducted in April 2007 to assess the performance of the remedial activities conducted at the AOCs and other areas. This event was conducted by an outside consultant on the LTM contract for DCF. All monitoring wells were purged and sampled based on the USACE Low Flow Protocol-Version 1.3 (USACE, 2002) with the exception of the manual inertial lift pump wells which were purged using a modified set of criteria. Analytical groundwater samples were not collected from monitoring wells with MnO_4^-, which included Monitoring Wells DCF02-42, DCF06-25, and Piezometer PSPZ-1. All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS. The monitoring well network for this sampling event is shown on Figure 1-2. The groundwater results for this sampling event are presented in Section 4.

3.21 JUNE 2007 GROUNDWATER INSTRUMENT MONITORING EVENT

The performance monitoring program for this event consisted of groundwater parameter monitoring at monitoring wells DCF92-01, DCF93-13, and DCF06-40 (Figure 2-3). The results for this event are presented in Section 4. This event was conducted to confirm purging results for these selected wells during the April 2007 full groundwater sampling event. Parameters monitored for included pH, temperature, conductivity, turbidity, ORP, and DO.

3.22 JULY 2007 GROUNDWATER INSTRUMENT MONITORING EVENT

The performance monitoring program for this event consisted of groundwater parameter monitoring at monitoring wells DCF92-05, DCF06-25, DCF06-40, DCF93-13, DCF02-41, DCF02-42, and Piezometer PSPZ-1 (Figure 2-3). The results for this event are presented in Section 4. This event was conducted to monitor the results for soil and groundwater remediation in AOC 1 (soil removal), AOC 2 (EAB Injection), and AOC 3 in-situ chemical oxidation. Parameters that were measured during post performance monitoring (Table 4-2) for AOC 2 included pH, temperature, conductivity, turbidity, ORP, and DO. Parameters that were measured during post performance monitoring (Table 4-2) for AOC 3 included visual observations for the presence of permanganate (purple-colored groundwater) and manganese dioxide (brownish sediments to confirm spent permanganate). Due to the presence of MnO_4 in Monitoring Wells DCF02-42 and DCF 06-25, ORP, pH, and VOC groundwater sample data were not collected during post-injection performance monitoring.

3.23 AUGUST 2007 GROUNDWATER INSTRUMENT MONITORING EVENT

The performance monitoring program for this event consisted of groundwater parameter monitoring at monitoring wells DCF92-05, DCF06-25, DCF06-40, DCF93-13, DCF02-41, DCF02-42, and Piezometer PSPZ-1 (Figure 2-3). The results for this event are presented in Section 4. This event was conducted to monitor the results for soil and groundwater remediation in AOC 1 (soil removal), AOC 2 (EAB Injection), and AOC 3 in-situ chemical oxidation. Parameters that were measured during post performance monitoring for AOC 2 included pH, temperature, conductivity, ORP, DO, ferrous iron, and total iron. Parameters that were measured during post performance monitoring for AOC 3 included visual observations for the presence of permanganate (purple-colored groundwater) and manganese dioxide (brownish sediments to confirm spent permanganate). Due to the presence of MnO_4 in Monitoring Wells DCF02-42 and DCF 06-25, ORP, pH, and VOC groundwater sample data were not collected during post-injection performance monitoring.

3.24 SEPTEMBER 2007 LIMITED GROUNDWATER SAMPLING EVENT

A limited groundwater sampling event was conducted in September 2007 to assess the performance of the remedial activities conducted at each AOC (excluding the Other Sites). Monitoring Wells sampled during this event included Monitoring Well DCF92-05, DCF93-13, DCF02-41, DCF02-44c, DCF02-49c, DCF06-40, and B354-99-11c. Analytical groundwater samples were not collected from monitoring wells with MnO_4^- which included Monitoring Wells DCF02-42, DCF06-25, and Piezometer PSPZ-1. The sampling and analytical requirements for this event are presented in Table 3-3. All monitoring wells were purged and sampled based on the USACE Low Flow Protocol-Version 1.3 (USACE, 2002). All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, September 2007 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2007b). The groundwater results for this sampling event are presented in Section 4.

3.25 OCTOBER 2007 LIMITED GROUNDWATER SAMPLING EVENT

A limited groundwater sampling event was conducted in October 2007 to assess the performance of the remedial activities conducted at AOC 3. Monitoring Wells sampled during this event included Monitoring Well DCF02-42 and DCF06-25. These monitoring wells were not sampled in the previous post-performance rounds due to the presence of permanganate. As noted above, samples from monitoring wells DCF06-25 and DCF02-42 were not originally collected during the September sampling event due to the presence of potassium permanganate. However, an estimate of the VOC concentrations in groundwater at these locations was required to provide additional information for the pilot study. Since there was concern that the potassium permanganate would interfere with the VOC analysis, it was necessary to neutralize the potassium permanganate in the field with ascorbic acid prior to analysis. Samples were collected from DCF06-25 and DCF02-42 on October 25, 2007 and submitted to CAS unpreserved. CAS then titrated the samples with ascorbic acid until the solution changed from purple to clear, which indicated reduction of potassium permanganate. Samples were then transferred to hydrochloric-acid preserved VOC vials and analyzed for VOCs by SW-846 8260B. Since the reduction of potassium permanganate required sample preparation and handling that could have resulted in some loss of VOCs, the VOC results for samples collected from Monitoring Wells DCF06-25 and DCF02-42 were considered screening-level quality only. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, September 2007 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2007b). The groundwater results for this sampling event are presented in Section 4.

3.26 INVESTIGATIVE DERIVED WASTE

Procedures for handling IDW at Fort Riley are described in the IDWMP (BMcD, 2003b). Site specific procedures that related exclusively to the pilot study are presented in the site specific IDWMP, Appendix B, of the WP. IDW handling associated with the field activities conducted during the pilot study are presented as follows:

- Post-performance monitoring events – Purge water was discharged to Manhole 173 (Figure 3-3, IDWMP).

- Monitoring Well DCF01-40 Abandonment and Replacement with DCF0640 – Decontamination liquid was transferred to the IDW holding tank at the landfarm treatment cell. Soil was stored in a UN-approved drums and transported to the landfarm treatment cell for treatment.

- Vadose Zone Assessment – Decontamination water was transferred to IDW holding tank at Landfarm treatment cell. Soil was stored in a UN-approved drum and transferred to the landfarm treatment cell for treatment when the cell was revitalized.

- Soil Excavation at AOC 1 – All decontamination water was transferred to the IDW holding tank at the landfarm treatment cell. All soil excavated from the AGL, the sanitary sewer lines, and the MHs that were above 1 ppm during field screening were transferred to the landfarm treatment cell for treatment. Once soil analytical results indicated that the soil concentrations for PCE, TCE, cis-1, 2-DCE, and VC were below the KDHE RSK for the soil to groundwater pathway, and then the soil from the treatment cell was transferred to the CD landfill and used as cover.

- $NaMnO^{-4}$ drums were cleaned and rinsed with water obtained from the non-chlorinated hydrant. The empty drums were taken to the Defense Reutilization and Marketing Office (DRMO). The rinsate was discharged directly to the soil being disked at the landfarm treatment cell. The EAB drums were discarded by EPS. The $KMnO^{-4}$ cycle bins were returned to Carus Chemical Company.

- Leachate from the landfarm treatment cell was sampled for PCE, TCE, cis-1,2-DCE, and VC. Once liquid analytical results indicated that the water concentrations for PCE, TCE, cis-1,2-DCE, and VC were below the KDHE RSK for the groundwater pathway, then the water stored in the IDW tank was discharged to MH 96 at Camp Funston (Figure 3-1, IDWMP).

All IDW samples results are presented in Section 4.

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4.0 PILOT STUDY DATA

This section presents the data from the field work conducted for the DCF Pilot Study. Data discussion and interpretation, and conclusions and recommendations based on the pilot study data are presented in Sections 5 and 6, respectively.

4.1 FALL 2005 GROUNDWATER SAMPLING DATA

A groundwater sampling event was conducted during October 2005 to provide a baseline for chlorinated solvent VOC concentrations within the pilot study area. Although this event was not tasked under this pilot study, it is included in the PSR because it was conducted immediately prior to the pilot study startup and provides the baseline data necessary for conducting a performance evaluation. The VOC analytical data from this event is presented in Table 4-1 and includes positive detections for PCE, TCE, cis-1,2-DCE, and VC. Because natural attenuation parameters were not collected during the fall 2005 event other than normal stabilization criteria, natural attenuation data from the spring 2005 groundwater sampling event were used as a baseline (Table 4-2). The monitoring well network is shown on Figure 1-2.

Chemicals of specific concern at the DCF Site include PCE, TCE, cis-1,2-DCE, and VC. Monitoring wells with VOC detections above the regulatory limit at the DCF Site during the fall 2005 are presented as follows:

PCE (>5 µg/L)		TCE (>5 µg/L)	cis-1,2-DCE (>70 µg/L)	VC (>2 µg/L)
92-05	02-44a	93-13	02-41	None
93-13	02-44c	06-25		
06-25	02-48c	02-41		
99-37c	02-49c	02-44a		
06-40	99-11c	02-44c		

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, temperature, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride.

Monitoring wells with favorable baseline geochemical conditions are presented as follows:

DO (<.5 mg/L)		ORP (<50 mV)		Nitrate (< 1 mg/L)		Methane (>500 µg/L)
00-34c	02-48a	93-19	99-37c	93-19	02-41	93-19
99-37c	02-48c	93-20	99-38c	93-20	02-43	
99-38c	02-49c	06-25	02-41	96-27	02-46a	
02-44a	02-50c	96-27	02-44a	00-34c	02-47a	
02-44c	99-11c	00-34c	02-48a	99-37c	02-48a	
				99-38c	03-50c	

mg/L = milligram per liter mV = milliVolt µg/L = microgram per Liter

4.2 VADOSE ZONE SOIL SAMPLE DATA

The soil in the vadose zone near Monitoring Well DCF02-42 in AOC 3 was suspected to be contaminated by leaking dry cleaning process waste water from the former Buildings 180/181 and from wastewater overflow of a MH 366. To assess the current subsurface chlorinated solvent concentrations in this area, soil samples were collected for field analysis using direct-push technology. The data from the vadose zone investigation are presented in Table 4-3.

Data indicate that PCE was detected at multiple depths with the highest concentration of 31.3 µg/kg at the 16-18 ft interval. All PCE detections were below the KDHE RSK Soil to Groundwater Pathway of 180 µg/kg. There were no detections for TCE and cis-1,2-DCE above the field laboratory detection limit of 8.4 µg/kg, which is below the KDHE RSK screening criteria for these analytes.

4.3 TREATABILITY BENCH STUDIES

Treatability bench studies were conducted on soil and groundwater collected from AOC 3. These studies were conducted to determine the NOM and the NOD for subsurface soils at the site. Because NOM and reduced metal species in the subsurface exert a significant oxidant demand that competes with the contaminants of concern for the available MnO_4^-, this natural demand for the oxidant must be satisfied before the oxidant can effectively react with and degrade all of the targeted compounds. To determine the amount of MnO_4^- needed to satisfy the natural demand for the oxidant, a NOD kinetic study was performed. A VOC destruction study was also performed on the soil samples to confirm the amount of MnO_4^- necessary to satisfy the NOD. The data from both of these studies are presented below.

Four soil samples and one groundwater sample was collected in November 2005 and sent to Carus Chemical Company for testing. The soils were collected at multiple intervals to represent different soil types. The groundwater was collected from Monitoring Well DCF 06-25 (formerly known as DCF 96-25). A 10-day kinetic demand study and a treatment study for VOC destruction was concurrently conducted. The groundwater and soil samples were analyzed for VOC compounds prior to the initiation of the study. Following treatment, the soil and groundwater samples as well as the control samples were analyzed for VOCs and compared to the initial baseline VOC data. Based on the soil demands, in-situ chemical oxidation using permanganate was recommended for the DCF Site. The permanganate soil oxidant demand values recommended for each soil type within the treatment area are defined as follows:

Soil Type	Sample Identification	$KMnO_4$ Demand (g/kg)	$NaMnO_4$ Demand (g/kg)
Clay - Vadose	TS-2 4/8 ft bgs	26.7	23.9
Silt - Vadose	TS-2 12/16 ft bgs	8.7	7.8
Silty Sand - Vadose	TS-2 20/24 ft bgs	6.9	6.2
Silty Sand - Saturated	TS-2 26/28 ft bgs	4.8	4.3

The Carus Chemical Company Technology and Quality Remediation Report are presented in Appendix H.

4.4 AOC 1 SOIL EXCAVATION ANALYTICAL DATA

From November 21 through December 16, 2005, shallow subsurface soil with PCE concentrations above the KDHE RSK soil to groundwater PCE screening value of 180 µg/kg was excavated at AOC 1 and transported to the landfarm treatment cell for treatment. There were two main areas that were excavated: Area #1, which was centered on former Building 180, and Area #2, which was centered around MH 363 (Figure 3-4). Additional soil excavation areas in AOC 1 included selected sanitary sewer lines, the MH 367 area, and the AGL.

4.4.1 AOC 1 and AOC 2 Excavations

The soil was excavated down to a depth of 8 ft bgs for Area #1 and to 8 ft and 12 ft bgs for Area #2. During excavation, selected soil samples were collected from the sidewalls and the bottom of each excavation for 24-hour turn-around-time analysis for PCE, TCE, cis-1,2-DCE and VC at the offsite laboratory. The samples were collected to confirm that soil concentrations for the targeted excavation areas were below the KDHE RSK soil to groundwater screening value of 180 µg/kg for PCE, 200 µg/kg for TCE, 800 µg/kg for cis-1,2-DCE, and 20 µg/kg for VC. The analytical data for the confirmation samples collected from AOC 1 and AOC 2 indicated that all concentrations for PCE, TCE, cis-1,2-DCE, and VC were below the KDHE RSKs. The analytical data are presented in Table 4-4. Additional information regarding the soil confirmation data can be found in the *Quality Control Summary Report for the Treatability Study Confirmation of Area 1 and Area 2 Excavation Samples, Dry Cleaning Facility Area, Main Post, Fort Riley, Kansas* (BMcD, 2006c).

Additionally, to confirm that hazardous constituents did not exist in the excavated soil and that the soil was not being improperly transported from the site to the landfarm treatment cell based on analytical data, one soil sample was collected from both Area #1 and Area #2 and analyzed for VOCs using USEPA Methods 1311/8260 for TCLP. Based on previous soil sample data for this area (Table 3-1), the TCLP sample was collected from the 1-4 ft depth at Area #1 and from the 4-8 ft depth at Area #2. Analytical data indicate that soil samples collected from Area #1 and Area #2 passed the TCLP test. This data is presented in Table 4-5. Additional information regarding the soil confirmation data can be found in the *Quality Control Summary Report for the Treatability Study Confirmation of Area 1 and Area 2 Excavation Samples, Dry Cleaning Facility Area, Main Post, Fort Riley, Kansas* (BMcD, 2006c).

4.4.2 Utility Corridor Excavation Data

The utility corridor excavation and treatment phase of the pilot study was undertaken because it was suspected that the utility corridor served as a conduit for contaminant transport of dry cleaning process wastewater that leaked from the sanitary sewers. This portion of the excavations focused on the AGL, the sanitary sewer line, MH 363, and MH 367. Excavations were conducted to confirm the presence or absence of chlorinated solvent contamination within the utility corridor (Figure 3-4). Excavations were conducted for selected portions of the utility corridor running parallel to Custer Road based on field GC data, the utility corridor from MH 363 northward to MH 365, MH 363 and the immediate surrounding area, and MH 367 and the immediate surrounding area. The area around MH 365 was only exposed to locate the suspected sanitary sewer line. Soil samples were collected and analyzed on site with a field GC. These samples were collected from the AGL bedding material, from the utility corridor between MH 363 and MH 365, and from excavation waste piles to confirm on-site PID readings.

The field GC and laboratory confirmation data are presented in Table 4-6. The data indicated the following:

Waste Pile

All data were below the 1 ppm field screening criteria (see Section 3.11.2.1).

Utility Corridor including Sanitary Sewer Line

All data were below the KDHE RSK soil to groundwater screening value of 180 μg/kg for PCE, 200 μg/kg for TCE, and 800 μg/kg for cis-1,2-DCE. Location UC-09, with a concentration of 7.8 J μg/kg for PCE, was the only location with a detection. The locations of these samples are shown on Figure 3-5.

AGL Corridor

All data were below the KDHE RSK soil to groundwater value of 180 μg/kg for PCE, 200 μg/kg for TCE, and 800 μg/kg for cis-1,2-DCE with the exception of UC-07/AGL, which had a PCE soil concentration of 479 J μg/kg (estimated). This sample was duplicated twice to confirm the first duplicate result. The original sample for AGL UC-07 was largely sand while the duplicates were largely silty clay. This location was east of the catch basin near the area of the MH 365 to MH 363 sanitary sewer line corridor. The locations of these samples are shown on Figure 3-7.

4.4.3 Landfarm Treatment Cell Confirmation Data

The landfarm treatment cell contained soil excavated from the AOC 1 area which included soil from Area #1 North, Area #1 South, Area #2, the sanitary sewer line, the AGL, and the MH excavations (see Figure 3-4). The total volume of soil removed from AOC 1 was stored at the landfarm treatment cell and the soil was tilled using 18-inch disks pulled by a tractor. The soil was disked twice each week during treatment to improve the volatilization of chlorinated solvents. Each tilling cycle was conducted for approximately three weeks and there were three separate soil treatment cycles. At the conclusion of each cycle, 12 samples were collected to confirm that the soil in the treatment cell was below the KDHE RSK standards for PCE, TCE, cis-1,2-DCE, and VC of 180, 200, 800, and 20 μg/kg, respectively. The soil analytical data from each treatment phase indicated that all soils sample data were below the KDHE RSKs. The data from each treatment phase are presented in Table 4-7.

Treatment cell leachate was also collected during three separate events. The leachate was stored in a polytanks at the treatment cell. Water that had collected in the treatment cell sump was pumped to the holding tank. The tank also contained decontamination water for various field activities. The leachate was sampled for PCE, TCE, cis1-2-DCE, and VC using USEPA Method 8260B. The data from the three separate leachate sampling events are presented on Table 4-7.

4.5 SPRING 2006 GROUNDWATER DATA

A groundwater sampling event was conducted in March 2006 to provide a second baseline for chlorinated solvent concentrations and natural attenuation parameters in AOC 2 and AOC 3 before high pressure and EAB injection activities were conducted. The sampling and analytical requirements for this event are presented in Table 3-3. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, Spring 2006 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2006a). The VOC analytical data from this event are presented in Table 4-8 and include positive detections for PCE, TCE, cis-1,2-DCE, and VC.

Monitoring wells with VOC detections above the regulatory limit at the DCF Site are presented as follows:

PCE (5 µg/L)		TCE (5 µg/L)	cis-1,2-DCE (70 µg/L)	VC (2 µg/L)
92-05	02-44a	93-13	02-41	93-19
93-13	02-44c	06-25		
06-25	02-48c	02-44a		
06-40	02-49c	02-44c		
02-42	99-11c			

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride. Natural attenuation parameters are presented in Table 4-9.

Monitoring wells with favorable baseline geochemical conditions for the spring 2006 groundwater sampling event are presented as follows:

DO (<.5 mg/L)	ORP (<50 mV)		Nitrate (< 1 mg/L)	Methane (>500 µg/L)
02-41	93-19	02-41	93-19	93-19
02-44a	96-27	02-48a	93-20	
02-44c	00-34c	02-49c	96-27	
02-47a	96-36		00-34c	
02-48a	99-38c		96-36	
			99-37c	
			99-38c	
			02-41	
			02-46a	
			02-47a	
			02-48a	
			03-50c	

4.6 FALL 2006 GROUNDWATER SAMPLING EVENT

A groundwater sampling event was conducted in October 2006 to monitor the effects of the high pressure and EAB injection activities conducted at AOC 2 and AOC 3. The sampling and analytical requirements for this event are presented in Table 3-3. Analytical groundwater samples were not collected from monitoring wells with MnO_4^-. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control*

Summary Report, Fall 2006 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas, (BMcD, 2006b). The VOC analytical data for this event are presented in Table 4-10 and includes positive detections for PCE, TCE, cis-1,2-DCE, trans-1,2-DCE and VC.

Monitoring wells with VOC detections above the regulatory limit at the DCF Site are presented as follows:

PCE (5 µg/L)		TCE (5 µg/L)	cis-1,2-DCE (70 µg/L)	VC (2 µg/L)
92-05	02-48c	96-27	02-41	93-19
93-13	02-49c	02-44a		
99-37c	06-40	02-44c		
02-44a	99-11c			
02-44c				

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride. Natural attenuation parameters are presented in Table 4-11.

Monitoring wells with favorable baseline geochemical conditions for the fall 2006 groundwater sampling event are presented as follows:

DO (<.5 mg/L)		ORP (<50 mV)		Nitrate (< 1 mg/L)		Methane (>500 µg/L)
00-34c	02-48a	92-05	02-44c	93-13	02-41	None
96-36	02-48c	93-13	02-46a	93-19	02-46a	
99-38c	02-49c	93-19	02-46c	93-20	02-46c	
02-41	02-50c	93-20	02-47a	96-27	02-47a	
02-47a	99-11c	96-27	02-47c	00-34c	02-48a	
		00-34c	02-48a	96-36	03-50c	
		96-36	02-48c	99-38c		
		99-38c	03-50c			
		02-41				

4.7 JANUARY 2007 GROUNDWATER SAMPLING EVENT

A limited groundwater sampling event was conducted in January 2007 to monitor the effects of the high pressure and EAB injection activities conducted at AOC 2 and AOC 3. Monitoring wells sampled during this event included Monitoring Well DCF92-05, DCF93-13, DCF02-41, DCF02-44c, DCF02-49c, DCF06-40, and B354-99-11c. Analytical groundwater samples were not collected from monitoring wells with MnO_4^- which included Monitoring Wells DCF02-42 and DCF06-25, and Piezometer PSPZ-1. The sampling and analytical requirements for this event are presented in Table 3-3. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, January 2007 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2007). The VOC analytical data for this event is presented in Table 4-12 and includes positive detections for PCE, TCE, trans-1,2-DCE, and cis-1,2-DCE.

Monitoring wells with VOC detections above the regulatory limit at the DCF are presented as follows:

PCE (5 µg/L)	TCE (5 µg/L)	cis-1,2-DCE (70 µg/L)	VC (2 µg/L)
93-13 06-40 02-44c 99-11c 02-49c	02-44c	02-41	None

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride. Natural attenuation parameters are presented in Table 4-13.

Monitoring wells with favorable baseline geochemical conditions for the spring 2007 groundwater sampling event are presented as follows:

DO (<.5 mg/L)	ORP (<50 mV)	Nitrate (< 1 mg/L)	Methane (>500 µg/L)
02-44c 02-49c B354-99-11c	92-05 93-13 02-41 02-49c B354-99-11c	92-05 93-13 02-41 02-49c	92-05

4.8 APRIL 2007 GROUNDWATER SAMPLING EVENT

A full long term monitoring groundwater sampling event was conducted by an outside consultant in April 2007. Groundwater data from this event is included in this report to provide additional monitoring data for the effects of the high pressure and EAB injection activities conducted at AOC 2 and AOC 3. The monitoring wells sampled during this event and the sampling and analytical requirements are presented in Table 3-3. Analytical groundwater samples were not collected from monitoring wells with MnO_4^- which included Monitoring Wells DCF02-42 and DCF06-25. The monitoring well network for this sampling event is shown on Figure 1-2. The VOC analytical data for this event is presented in Table 4-14 and includes positive detections for PCE, TCE, cis-1,2-DCE, and VC.

Monitoring wells with VOC detections above the regulatory limit at the DCF Site are presented as follows:

PCE (5 µg/L)		TCE (5 µg/L)	cis-1,2-DCE (70 µg/L)	VC (2 µg/L)
06-40	02-48c	02-44a	02-41	93-19
02-44a	02-49c	02-44c		
02-44c	99-11c	02-49c		

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride. Natural attenuation parameters are presented in Table 4-15.

Monitoring wells with favorable baseline geochemical conditions for the spring 2007 groundwater sampling event are presented as follows:

DO (<.5 mg/L)	ORP (<50 mV)	Nitrate (< 1 mg/L)	Methane (>500 µg/L)
02-50c	92-05	92-05	92-05
	93-13	93-13	93-13
	93-19	93-19	93-19
	93-20	93-20	99-37c
	96-27	96-27	
	96-36	00-34c	
	99-37c	96-36	
	99-38c	96-37c	
	02-41	99-38c	
	02-48a	02-41	
	02-49c	02-46a	
	B354-99-11c	02-47a	
		02-48a	
		02-49c	
		03-50c	

4.9 SEPTEMBER AND OCTOBER 2007 GROUNDWATER SAMPLING EVENT

A limited groundwater sampling event was conducted in September and October 2007 to monitor the effects of the high pressure and EAB injection activities conducted at AOC 2 and AOC 3. Monitoring wells sampled during the September event included Monitoring Well DCF92-05, DCF93-13, DCF02-41, DCF02-44c, DCF02-49c, DCF06-40, and B354-99-11c. Monitoring wells sampled during the October event included Monitoring Well DCF06-25 and DCF02-42. The sampling and analytical requirements for this event are presented in Table 3-3. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, September 2007 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2007b). The VOC analytical data for this event is presented in Table 4-16 and includes positive detections for PCE, TCE, trans-1,2-DCE, and cis-1,2-DCE.

Monitoring wells with VOC detections above the regulatory limit at the DCF are presented as follows:

PCE (5 µg/L)	TCE (5 µg/L)	cis-1,2-DCE (70 µg/L)	VC (2 µg/L)
02-42 06-40 02-44c	02-49c	02-41	None

Natural attenuation parameters monitored at the DCF Site include sampling stabilization parameters and analytical parameters. Stabilization parameters include temperature, pH, conductivity, and turbidity. Natural attenuation parameters include methane, ethane, ethene, alkalinity, total organic carbon, nitrate, sulfate, sulfide, ORP, DO, Fe II, and chloride. Natural attenuation parameters are presented in Table 4-13.

Monitoring wells with favorable baseline geochemical conditions for the spring 2007 groundwater sampling event are presented as follows:

DO (<.5 mg/L)	ORP (<50 mV)	Nitrate (< 1 mg/L)	Methane (>500 µg/L)
93-13	92-05	92-05	92-05
06-40	93-13	93-13	93-13
02-41	06-40	02-41	06-40
B354-99-11c	02-41	02-49c	
	02-44c	B354-99-11c	
	02-49c		
	B354-99-11c		

4.9 POST-INJECTION PERFORMANCE MONITORING DATA

Post-injection performance monitoring data was collected from relevant monitoring wells to augment data collected during the groundwater sampling events that occurred during the course of the Pilot Study. The data was collected approximately monthly from March 2006 through December 2006, and from June 2007 through August 2007 (see Table 3-2). All data was collected via visual observation and field meters.

For monitoring wells in the areas of permanganate injection, visual observation for the presence of MnO_4^- and manganese dioxide were conducted. Because MNO_4^- was present in each well monitored from the time of injection through August 2007, pH and ORP measurements were not necessary.

For monitoring wells in the areas of CAP18™ injection, parameters measured included pH, DO, ORP, total iron, and ferrous iron. These parameters were measured using a low flow multi-channel meter, a flow cell, and dedicated bladder pumps. Groundwater was purged from each monitoring well using carbon dioxide carrier gas for several measurement cycles.

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5.0 DATA DISCUSSION AND INTERPRETATION

This section provides the discussion and interpretation of data collected during the pilot study in relation to the overall project objectives and specific objectives for each AOC presented in Section 2.

5.1 AOC 1

The project objectives for implementation of the DCFA Pilot Study were to determine the feasibility of in-situ and ex-situ treatment of shallow soils and the utility corridor at AOC 1. The AOC 1 pilot study treatment components included the following:

- Excavation of shallow soil to 8 ft bgs at Area #1 and transport excavated soil to a landfarm treatment cell
- Excavation of shallow soil to 12 ft bgs at Area #2 and transport excavated soil to a landfarm treatment cell
- Removal of backfill and exposure of selected sewer lines and MHs with transportation of excavated soil to a landfarm treatment cell
- Removal of backfill and exposure of selected portions of the AGL and transport of excavated soil to a landfarm treatment cell
- Injection of sodium permanganate into selected sewer lines, MHs, and the AGL

5.1.1 Area #1 and Area #2 Soils

Area #1 and Area #2 consists of two areas of soil contamination near former Buildings 180/181 that contained shallow, chlorinated solvent contaminated soil with concentrations above the KDHE RSK for PCE. PCE in soil was detected to a depth of 12 ft bgs in concentrations that exceeded the KDHE RSK of 180 μg/kg for the soil to groundwater protection pathway. The purpose of the pilot study for soil remediation at Area #1 and Area #2 was to evaluate effective remedial technologies that would achieve the desired cleanup objectives at a reasonable cost.

The following provides a discussion of specific treatability study objectives for Area #1 and Area#2:

<u>To evaluate the effectiveness of shallow soil excavation and landfarming</u>

All soil with concentrations that exceeded the KDHE RSK of 180 μg/kg for the soil to groundwater protection pathway were excavated and removed to an approximate depth of 12 ft bgs. The soil was treated at the landfarm and once it was established by analytical sampling that all soils in the landfarm were below the KDHE RSK of 180 μg/kg, then this soil was transported to the CD landfill and used as cover. This treatment option effectively removed the contaminated shallow soil source area near former Buildings 180/181 that had been defined during previous investigations.

To evaluate whether removal of the contaminated soil will prevent infiltration of precipitation through a contaminated soil zone to subsurface groundwater

Once the contaminated soil was removed, soil samples were collected from the bottom of the excavation to provide an accurate analytical profile for soil COPC concentrations in these two areas. Laboratory results indicated that the soil beneath the excavations were below the KDHE RSK for each COPC. Following excavation sampling, clean, high clay content soil was used as backfill. Consequently, removal of the shallow contaminated soil zone and replacing this soil with clean soil has removed the possibility of precipitation infiltration through soil contaminated with the COPC above the KDHE RSK: This treatment option effectively removed the infiltration pathway through a contaminated soil zone in this area.

To evaluate whether this treatment method reduces long-term monitoring time and cost

Removal of the shallow contaminated soil has prevented infiltration of precipitation through a shallow contaminated soil zone and has reduced the contribution of PCE to groundwater in this area. Reduction of PCE infiltration to groundwater has quantitatively reduced the long-term monitoring time and cost in this area.

5.1.2 Utility Corridor

The utility corridor treatment area was part of the DCFA pilot study based on previous sewer line investigations conducted in 1992, 1993, and 1994 in which sanitary/storm sewer sediment samples had elevated concentrations of PCE, TCE, and cis-1,2-DCE at MH 363. The suspected utility corridor area was divided into two locations, one location south of Custer Road near the former location of Buildings 180/181 and the other location north of Custer Road near former Buildings 183/184. The first location included the AGL and the MH 363 area and the second portion was located at MH 367 and extended southeast toward MH 365 and MH 363. The purpose of the pilot study for soil remediation within the utility corridor was to evaluate whether this area was a potential contaminated source area and if so, could this area be effectively treated with remedial technologies that would achieve the desired cleanup objectives at a reasonable cost. The following provides a discussion of specific treatability study objectives of the utility corridor:

To evaluate the utility corridor as a conduit for the transport of process wastewater contamination

Selected portions of the AGL, the sanitary sewer line from MH 363 to MH 365, and MH 363 were excavated to determine if these areas served as a conduit for the transport of contaminated process waste water during active dry cleaning operations. Field GC and laboratory results indicated that some chlorinated solvent contamination was present in the utility corridor backfill located between MH 363 and MH 365 and along the AGL near the storm water surface grate. Consequently, the analytical results indicate that the utility corridor has historically served in some capacity as a conduit for the movement of contaminated process wastewater.

To evaluate chemical oxidation as a viable technical option for the treatment of the utility corridor

Once the corridors were exposed and sampled, they were easily available for in-situ chemical oxidation treatment for the excavated corridors, the suspected sanitary sewer line, and the MHs. Access points were cut into the sanitary sewer lines and the MHs for injection of sodium permanganate. Based on the field GC and laboratory analytical results and ease of treatment for the utility corridor backfill, chemical oxidation using sodium permanganate was a viable treatment option.

To evaluate whether chemical oxidation will reduce soil, sediment, and backfill contamination within the utility corridor to concentrations below the KDHE RSKs

It is quantitatively assumed that chemical oxidation treatment of the utility corridor was a viable treatment option and that this option has reduced the soil and backfill contamination to concentrations below the KDHE RSKs for the COPCs based on the following:

- The relatively low PCE field GC and laboratory analytical results for the backfill removed from the AGL and the sanitary sewer lines
- The absence of TCE, cis-1,2-DCE, and VC detections in soil
- The backfill surrounding the AGL, the sanitary sewer lines, and the MHs were excavated and transported to the landfarm treatment cell
- Based on the fact that the amount and percentage of sodium permanganate injected into these areas was of a sufficient oxidant load to remove the COPC contamination based on the reported concentrations
- The excavations were backfilled with clean soil
- MHs 367 and 363 as well as the sanitary sewer line connecting MH 367 to 365 to 363 were also injected with sodium permanganate to remove these areas as possible source areas.

To evaluate whether this treatment method reduces long-term monitoring time and cost

Excavation and removal together with in-situ chemical oxidation treatment of contaminated soil within the utility corridor, treatment of the MHs and sanitary sewer lines, and treatment of the AGL has prevented infiltration of precipitation or movement of water from leaking storm sewer lines through a shallow contaminated soil zone and has reduced the contribution of PCE to groundwater in this area. This treatment option effectively reduces long-term monitoring time and cost in this area based on the removal and treatment of shallow contaminated soil.

5.2 AOC 2

Contaminated groundwater in AOC 2 is located within a bedrock erosional channel in the vicinity of Monitoring Wells DCF06-40 and DCF93-13. The axis of the channel is oriented in a northeast/southwest direction and extends under the UPRR to the Kansas River alluvium. Portions of this channel lie beneath the former Building 180 location. The groundwater contamination in AOC 2 has naturally attenuated over time, but still has concentrations above the KDHE RSK and MCL of 5 μg/L for PCE.

The project objective for AOC 2 was to determine the feasibility of full-scale in-situ treatment of groundwater contamination using EAB while maximizing the treatment area and contaminant mass removed. The AOC 2 pilot study treatment components included the following:

- Injection of CAP18™ at 73 injection locations as shown on Figure 3-12 and discussed in Section 3.17.2.2.
- Pre-injection and post-injection performance monitoring at monitoring wells in AOC 2 (DCF92-05, DCF06-40, DCF93-13, and DCF02-41.

5.2.1 Performance Monitoring Data

Performance monitoring data was collected from the above listed monitoring wells to evaluate the effectiveness of EAB in enhancing the natural attenuation of COPCs in groundwater in AOC 2. Tables 5-1 through 5-4 summarizes this data for each well. The tables include pre-injection data back to 2002 to aid in the trend analysis. For visualization of trends, Figures 5-1 through 5-5 are charts of data values over time for the following key parameters: PCE, DO, ORP, Ferrous Iron, and Sulfate.

For all three monitoring wells in the immediate area of injection (DCF92-05, DCF 93-13, and DCF06-40), the post-injection data trends are very positive for PCE, DO, and ORP. For these three wells, there is a reduction of PCE concentrations, DO levels have reduced, and ORP is significantly negative (approximately -200 mV). The results for ferrous iron levels are mixed, with substantial increases in ferrous iron concentration for Monitoring Well DCF92-05, a limited increase for Monitoring Well DCF93-13, and no change for Monitoring Well DCF06-40. Sulfate results were also mixed with initial sulfate reductions for all three monitoring wells during the middle portion of the post injection monitoring period, but Monitoring Wells DCF92-05 and DCF93-13 increased in sulfate concentration based on the results of the September 2007 Groundwater Sampling Event. Favorable sulfate results are evident for Monitoring Well DCF06-40, which has shown a steadily declining sulfate concentration during the monitoring period. These parameters indicate favorable anaerobic degradation conditions have been established in the AOC 2 area. An additional indication of favorable anaerobic degradation conditions is the significant concentrations of methane present in treatment area monitoring wells during the last two sampling events conducted in April and September 2007.

These conditions have resulted in an accelerated decline in PCE concentrations for Monitoring Well DCF06-40 with PCE concentration levels in DCF92-05 now below the KDHE RSK and MCL value. Additionally, the breakdown products TCE and cis-1,2-DCE are now being detected at low levels for Monitoring Well DCF06-40, which has historically exhibited only PCE concentrations.

Data from DCF02-41 was not included in the charts because of its significant distance from the injection area. Data from this well was collected to aid in the analysis of the overall conditions of groundwater in AOC 2, but impacts from injection were not expected during the course of this pilot study.

5.2.2 Treatability Study Objectives

The data collected has been analyzed with respect to the specific treatability study objectives for AOC 2. The results are discussed below.

To evaluate EAB as a viable technical option for the treatment of the groundwater contamination

Based on the performance monitoring data, EAB via the injection of CAP18™ is a viable technical option for groundwater remediation at AOC 2. As discussed above, the data trends are favorable for EAB. Also, the injection methodology worked as planned, and the targeted substrate mass was efficiently delivered to the treatment area.

To evaluate EAB as an effective method to enhance the natural attenuation of groundwater in the bedrock erosional channel

Based on the performance monitoring data, EAB via the injection of CAP18™ is an effective method to enhance the natural attenuation of COPCs in groundwater in AOC 2 within the overburden above the bedrock interface.

To evaluate if EAB will reduce groundwater contamination within AOC 2 to concentrations below the KDHE RSKs and the USEPA MCLs

The performance monitoring data indicates that EAB via the injection of CAP18™ can reduce COPC concentrations in AOC 2 below the KDHE RSKs and MCLs. During the pilot study, this was achieved for Monitoring Well DCF92-05, and PCE concentrations in Monitoring Wells DCF93-13 and DCF06-40 are approaching these clean-up objectives.

To evaluate if EAB will reduce long-term monitoring time and cost

The performance monitoring data indicates that long-term monitoring time can be reduced using EAB via the injection of CAP18™. Within the treatment area for the pilot study, natural attenuation of COPCs in groundwater was enhanced. This will ultimately reduce the required time for long-term monitoring.

5.3 AOC 3

In AOC 3, it is suspected that subsurface soil in the vadose zone near Monitoring Well DCF02-42 was contaminated by leaking drycleaning process waste water from the former Buildings 180/181 area or from MH overflow at the former Building 183/184 area. Contaminated groundwater is present near Monitoring Well DCF02-42 and extends southeastward to Monitoring Well DCF 06-25, which is approximately 230 ft downgradient (Figure 3-10). This area is located in the western portion of the DCF and is the approximate point where the western plume enters the Kansas River alluvium.

The project objective for AOC 3 was to determine the feasibility of full-scale in-situ treatment of soil and groundwater contamination using chemical oxidation while maximizing the treatment area and contaminant mass removed. The AOC 3 pilot study treatment components included the following:

- A soil matrix treatability study was conducted to evaluate the NOD of the soil within the vadose zone and saturated zone. The NOD is primarily a function of the natural organic content of the soil and the oxidizable minerals/mineral surfaces present.
- Injection of sodium permanganate in the vadose zone at 23 injection locations as shown on Figure 3-9 and discussed in Section 3.13.
- Injection of potassium permanganate in the saturated zone at 44 injection locations as shown on Figure 3-10 and discussed in Section 3.16.
- Post-injection performance monitoring at monitoring wells in AOC 3 (DCF02-42, DCF06-25, and PSPZ-1).

5.3.1 Performance Monitoring Data

Post-injection data was collected approximately monthly from March 2006 through December 2006, and from June 2007 through August 2007 (see Table 3-2). In AOC 3, all data was collected via visual observation because MnO_4^- was present in each well monitored from the time of injection through September 2007. The long-term presence of MnO_4^- indicates that the NOD had been overcome during this time interval. Observations collected in October 2007 indicated that the oxidant was no longer present in Monitoring Wells DCF02-42 and DCF06-25. The analytical data collected in October 2007 from these two monitoring wells indicates a reduction of PCE concentrations (see Table 4-16). For Monitoring Well DCF02-42, concentrations of PCE reduced from 58.9 µg/L (Pre-Treatment, March 2006) to 29.1 µg/L (Post-Treatment, October 2007). For Monitoring Well DCF06-25, concentrations of PCE reduced from 62.4 µg/L (Pre-Treatment, March 2006) to 8.0 µg/L (Post-Treatment, October 2007). This data does indicate that oxidant treatment in the areas near these two wells have resulted in significant reduction in PCE concentrations.

5.3.2 Treatability Study Objectives

The data collected has been analyzed with respect to the specific treatability study objectives for both the vadose zone and groundwater in AOC 3. The results are discussed below.

To evaluate the treatment method for remediation of vadose zone soil contamination near Monitoring Well DCF02-42

The vadose zone soil was treated by the injection of a 3% sodium permanganate solution via direct-push rods using an injection pump and accessories. There was some difficulty injecting in certain locations at various depths due to daylighting of the solution up the direct-push rods. However, this was overcome by off-setting horizontally and vertically, and overall the targeted mass of permanganate was injected in each treatment interval.

To evaluate whether the treatment method will reduce or eliminate the leaching of groundwater through a contaminated soil zone

Because the treatment method was able to deliver the overall targeted mass of permanganate in the various treatment intervals of the vadose zone, the potential for additional leaching to groundwater is minimal.

To evaluate chemical oxidation as a viable technical option for the treatment of the groundwater contamination

The high-pressure jetting technique was successful at delivering the targeted mass of permanganate within the saturated treatment zone very efficiently. The long-term presence of MnO_4^- in the monitoring wells after injection indicates that the NOD was overcome and PCE concentration reduction was obtained.

To evaluate whether chemical oxidation will reduce groundwater contamination within AOC 3 to concentrations below the KDHE RSKs and the USEPA MCLs

Based on recent groundwater analytical data for Monitoring Wells DCF02-42 and DCF06-25 (see Table 4-16), the COPC concentrations within AOC 3 are reducing toward the KDHE RSKs and the USEPA MCLs.

To evaluate whether chemical oxidation will reduce long-term monitoring time and cost

The data indicates that long-term monitoring time and cost will be reduced via chemical oxidation using permanganate.

5.4 OTHER AREAS

EAB treatment of groundwater was also pilot tested in the vicinity of three additional monitoring wells that have exhibited COPC concentrations above KDHE RSKs and MCLs. Monitoring Well DCF 02-49c is located on the Island near the Kansas River, and Monitoring Wells DCF99-37c and B354 99-11c are located near the Horse Corral (see Figure 3-13).

The project objective for the Other Areas was the same as for AOC 2; to determine the feasibility of full-scale in-situ treatment of groundwater contamination using EAB while maximizing the treatment area and contaminant mass removed. The Other Areas pilot study treatment components included the following:

- Injection of CAP18™ at 11 injection locations near DCF 02-49c and 8 injection locations each near DCF99-37c and B354 99-11c (Figures 3-14 through 3-16).
- Pre-injection and post-injection performance monitoring at the monitoring wells.

5.4.1 Performance Monitoring Data

Performance monitoring data was collected from the above listed monitoring wells to evaluate the effectiveness of EAB in enhancing the natural attenuation of COPCs in groundwater in the Other Areas. Tables 5-5 through 5-7 summarize this data for each well. The tables include pre-injection data back to 2002 to aid in the trend analysis. For visualization of trends, Figures 5-6 through 5-10 are charts of data values over time for Monitoring Wells DCF02-49c, DCF99-37c, and B354-99-11c for the following key parameters: PCE, DO, ORP, Ferrous Iron, and Sulfate.

Injection activities in the Other Areas were conducted approximately 4 months after the injection in AOC 2. This means there has been less time for favorable anaerobic degradation conditions to be established in these areas compared to AOC 2. However, the data trends indicate that favorable reducing conditions are being established at each well; PCE concentrations have reduced to concentrations below the KDHE RSK and the USEPA MCLs for all three monitoring wells, DO levels have either reduced or were relatively stable, and ORP measurements are significantly negative. Concentrations of ferrous iron have increased in Monitoring Well DCF02-49c and DCF99-37c while remaining steady for Monitoring Well B354-99-11c. Sulfate concentrations are also decreasing for all three monitoring wells evaluated with substantial decreases for Monitoring Well B354-99-11c and DCF99-37c.

5.4.2 Treatability Study Objectives

The data collected has been analyzed with respect to the specific treatability study objectives for the Other Areas. The results are discussed below.

To evaluate EAB as a viable technical option for the treatment of the groundwater contamination

Based on the performance monitoring data, EAB via the injection of CAP18™ is a viable technical option for groundwater remediation at the Other Areas. As discussed above, the data trends are favorable for EAB. Also, the injection methodology worked as planned, and the targeted substrate mass was efficiently delivered to the treatment area.

To evaluate EAB as an effective method to enhance the natural attenuation of groundwater

Based on the performance monitoring data, EAB via the injection of CAP18™ is an effective method to enhance the natural attenuation of COPCs in groundwater in the Other Areas.

To evaluate if EAB will reduce groundwater contamination within the Other Areas to concentrations below the KDHE RSKs and the USEPA MCLs

Based on recent groundwater analytical data for Monitoring Wells DCF02-49c, DCF99-37c, and B354-99-11c, the PCE concentrations within the Other Areas treatment zone have reduced to levels below the KDHE RSKs and the USEPA MCLs.

To evaluate if EAB will reduce long-term monitoring time and cost

The performance monitoring data indicates that long-term monitoring time can be reduced using EAB via the injection of CAP18™. Within the treatment area for the pilot study, natural attenuation of COPCs in groundwater was enhanced. This will ultimately reduce the required time for long-term monitoring.

* * * * * *

6.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides the conclusions and recommendations of the pilot study in relation to the overall project objectives and specific performance objectives presented in Section 2. The conclusions and recommendations are based on the data discussion and interpretation provided in the previous section.

6.1 AOC 1

The project objectives for the DCFA Pilot Study were to determine the feasibility of in-situ and ex-situ treatment of shallow soils in Area #1, Area #2, and the utility corridor. The AOC 1 pilot study treatment components included excavation and landfarm treatment of shallow contaminated soil and injection of sodium permanganate in the utility corridor.

6.1.1 Area #1 and Area #2 Soils

Area #1 and Area #2 consists of two areas of soil contamination near former Buildings 180/181 that contained shallow, chlorinated solvent contaminated soil with concentrations above the KDHE RSK for PCE. The purpose of the pilot study for soil remediation at Area #1 and Area #2 was to evaluate effective remedial technologies that would achieve the desired cleanup objectives at a reasonable cost.

To achieve the DCFA Pilot Study treatment study objectives, a treatment evaluation was conducted to determine the effectiveness of shallow soil excavation and landfarming; to determine whether removal of the contaminated soil would prevent infiltration of precipitation through a contaminated soil zone to subsurface groundwater; and to evaluate whether these treatment methods reduced long-term monitoring time and cost.

6.1.1.1 Conclusions

Based on data collected during performance of the DCFA Pilot Study for Area #1 and Area #2 soils, the following conclusions are drawn:

- Based on subsurface soil results presented in Table 2-1, all soil with concentrations that exceeded the KDHE RSK of 180 µg/kg for the soil to groundwater protection pathway were excavated and removed to an approximate depth of 12 ft bgs.
- Laboratory results indicated that the soil beneath the excavations were below the KDHE RSK for each COPC.

- Removal of the shallow contaminated soil has prevented infiltration of precipitation through a shallow contaminated soil zone and has reduced the contribution of PCE to groundwater in this area.

- Reduction of PCE infiltration to groundwater has quantitatively reduced the long-term monitoring time and cost in this area.

6.1.1.2 Recommendations

Based on the results of the DCFA Pilot Study, no further remedial treatment is recommended for AOC 1 soils in Area #1 and Area #2.

6.1.2 Utility Corridor

The utility corridor treatment area was part of the DCFA pilot study based on previous sewer line investigations. The suspected utility corridor area includes one location south of Custer Road near the former Buildings 180/181 and the other location north of Custer Road near former Buildings 183/184. The purpose of the pilot study for soil remediation within the utility corridor was to evaluate if this area was a potential source area for the COPCs and could this area be effectively treated with remedial technologies that would achieve the desired cleanup objectives at a reasonable cost.

To achieve the DCFA Pilot Study treatment objectives for the utility corridor, a treatment evaluation was conducted to determine the following:

- To determine if the utility corridor served as a conduit for the transport of process wastewater contamination

- To determine if chemical oxidation would be a viable technical method for the treatment of the utility corridor

- To determine if chemical oxidation would reduce soil, sediment, and backfill contamination within the utility corridor to concentrations below the KDHE RSKs

- To determine if these treatment methods would reduce long-term monitoring time and cost

6.1.2.1 Conclusions

Based on data collected during performance of the DCFA Pilot Study for the utility corridor, the following conclusions are drawn:

- Analytical results indicated that some chlorinated solvent contamination was present in the utility corridor backfill and along the AGL. Consequently, the analytical results indicate that the utility corridor has historically served in some capacity as a conduit for the movement of contaminated process wastewater.

- Based on the ease of the treatment process for the utility corridor including the excavated trenches, the MHs, and the sewer lines, chemical oxidation using sodium permanganate is a viable treatment option.

- Quantitatively, chemical oxidation treatment combined with soil excavation and removal are viable treatment options and have reduced the soil and backfill contamination toward concentrations below the KDHE RSKs for the COPCs.

- Reduction of PCE infiltration to groundwater has quantitatively reduced the long-term monitoring time and cost in this area based on removal of excavated utility corridor backfill to the landfarm treatment cell, treatment of the utility corridor with sodium permanganate, and backfilling the utility corridor with clean soil.

6.1.2.2 Recommendations

Based on the results of the DCFA Pilot Study, no further remedial treatment is recommended for the utility corridor in AOC 1.

6.2 AOC 2

The project objective for AOC 2 was to determine the feasibility of full-scale in-situ treatment of groundwater contamination using EAB while maximizing the treatment area and contaminant mass removed. Contaminated groundwater in AOC 2 is located within a bedrock erosional channel in the vicinity of Monitoring Wells DCF06-40 and DCF93-13. The groundwater contamination in AOC 2 has naturally attenuated over time, but still has concentrations above the KDHE RSK and MCL of 5 µg/L for PCE. The AOC 2 pilot study treatment components included the injection of CAP18™ within the targeted treatment area, and pre- and post-injection performance monitoring at monitoring wells in AOC 2 (DCF92-05, DCF06-40, DCF93-13, and DCF02-41).

6.2.1 Conclusions

Based on performance monitoring data for collected for Monitoring Wells DCF92-05, DCF93-13, and DCF06-40, very positive trends in key parameters, indicating a reducing environment has been established. Based on these results and data collected regarding the injection process, the following conclusions are made for AOC 2:

- EAB via the injection of CAP18™ is a viable technical option for groundwater remediation at AOC 2. As discussed in Section 5, the data trends are favorable for EAB. Also, the injection methodology worked as planned, and the targeted substrate mass was efficiently delivered to the treatment.

- EAB via the injection of CAP18™ is an effective method to enhance the natural attenuation of COPCs in groundwater in AOC 2 within the overburden above the bedrock interface.

- EAB via the injection of CAP18™ can reduce COPC concentrations in AOC 2 below the KDHE RSKs and MCLs as demonstrated for Monitoring Wells DCF92-05 and DCF93-13 with a substantial reduction in PCE concentration for Monitoring Well DCF06-40.

- Long-term monitoring time can be reduced using EAB via the injection of CAP18™ due to the enhanced natural attenuation of COPCs in groundwater.

6.2.2 Recommendations

Based on performance monitoring data, no additional injection of Cap 18 ™ is needed at this time within AOC 2. Performance monitoring data should continue to be collected as part of the annual groundwater sampling events. This data should be evaluated to determine progress toward remediation goals and if there is any need for additional Cap 18 ™ treatment.

6.3 AOC 3

The project objective for AOC 3 was to determine the feasibility of full-scale in-situ treatment of soil and groundwater contamination using chemical oxidation while maximizing the treatment area and contaminant mass removed. In AOC 3, contaminated groundwater is present near Monitoring Well DCF02-42 and extends southeastward to Monitoring Well DCF06-25, which is approximately 230 ft downgradient (Figure 3-10). This area is located in the western portion of the DCF and is the approximate point where the western plume enters the Kansas River alluvium. The AOC 3 pilot study treatment components included a soil matrix treatability study to determine NOD of the soil within the vadose zone and saturated zone, injection of sodium permanganate in the vadose zone at 23 injection locations, injection of potassium permanganate in the saturated zone at 44 injection locations, and post-injection performance monitoring at monitoring wells in AOC 3 (DCF02-42, DCF06-25, and PSPZ-1).

6.3.1 Conclusions

Post-injection data collected in AOC 3 indicates that full-scale in-situ treatment of soil and groundwater contamination using chemical oxidation with permanganate is feasible. The long-term presence of MnO_4^- within the saturated zone [from the time of injection (May 2006) through the period of data collection for the pilot study (September 2007)] indicates that the NOD had been overcome during this monitoring interval. Analytical data collected in October 2007 from Monitoring Wells DCF02-42 and DCF06-25 shows a reduction in PCE concentration for these two monitoring wells. This data does indicate that oxidant treatment in the areas near these two wells have resulted in significant reduction in PCE concentrations. Other conclusions from the pilot study in AOC 3 are as follows:

- The vadose zone treatment method (injection of a 3% sodium permanganate solution via direct-push rods using an injection pump and accessories) was successful. There was some difficulty injecting in certain locations due to daylighting of the solution. However, this was overcome by off-setting horizontally and vertically, and overall the targeted mass of permanganate was injected in each treatment interval.

- The potential for additional leaching of COPCs from the vadose zone to groundwater is minimal because the treatment method was able to deliver the overall targeted mass of permanganate in the various treatment intervals of the vadose zone.

- The high-pressure jetting technique was successful at delivering the targeted mass of permanganate within the saturated treatment zone very efficiently.

- Based on recent groundwater analytical data for Monitoring Wells DCF02-42 and DCF06-25, the COPC concentrations within AOC 3 are reducing toward the KDHE RSKs and the USEPA MCLs.

- Long-term monitoring time can be reduced via chemical oxidation with permanganate.

6.3.2 Recommendations

Based on the performance monitoring data, no additional injection of permanganate is needed at this time within the vadose zone or groundwater in AOC 3. Performance monitoring data should continue to be collected as part of the annual groundwater sampling events. This data should be evaluated to determine progress toward remediation goals and if there is any need for additional permanganate treatment.

6.4 OTHER AREAS

The project objective for the Other Areas was the same as for AOC 2, to determine the feasibility of full-scale in-situ treatment of groundwater contamination using EAB while maximizing the treatment area and contaminant mass removed. The Other Areas are the areas in the vicinity of three additional monitoring wells that have exhibited COPC concentrations above KDHE RSKs and MCLs (DCF 02-49c is located on the Island near the Kansas River, and DCF99-37c and B354 99-11c are located near the Horse Corral). The Other Areas pilot study treatment components included the injection of CAP18™ within the targeted treatment areas, and pre- and post-injection performance monitoring at the nearby monitoring wells (DCF 02-49c, DCF99-37c, and B354 99-11c).

6.4.1 Conclusions

The data trends indicate that favorable reducing conditions are being established at the treatment areas near Monitoring Wells DCF02-49c, DCF99-37c, and B354 99-11c; PCE concentrations have reduced to concentrations below the KDHE RSK and the USEPA MCLs for all three monitoring wells, DO levels have reduced or were stable, and ORP measurements are significantly negative. Concentrations of ferrous iron have increased or remained steady and sulfate concentrations are also decreasing for all three monitoring wells.

Based on the current monitoring data and data collected regarding the injection process, the following conclusions are made for the Other Areas:

- EAB via the injection of CAP18™ is a viable technical option for groundwater remediation at the Other Areas. The injection methodology worked as planned, and the targeted substrate mass was efficiently delivered to the treatment area.

- It appears that EAB via the injection of CAP18™ is an effective method to enhance the natural attenuation of COPCs in groundwater at the Other Areas.

6.4.2 Recommendations

Based on performance monitoring data, no additional injection of Cap 18 ™ is needed at this time within AOC 2. Performance monitoring data should continue to be collected as part of the annual groundwater sampling events. This data should be evaluated to determine progress toward remediation goals and if there is any need for additional Cap 18 ™ treatment.

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Tables

Table 2-1
Subsurface Soil PCE Results - Former Buildings 180/181 Area
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Borehole Number	Date Samples Collected	Sample Number/Sample Interval Depth Range (Results in ug/kg)										
		SB01 1 to 4 ft bgs	SB02 4 to 8 ft bgs	SB03 8 to 12 ft bgs	SB04 12 to 16 ft bgs	SB05 16 to 20 ft bgs	SB06 20 to 24 ft bgs	SB07 24 to 28 ft bgs	SB08 28 to 32 ft bgs	SB09 32 to 36 ft bgs	SB10 36 to 40 ft bgs	SB11 40 to 44 ft bgs
401	06/03/02	11	15.6	5.4U	5.6U	6U	9.7	8.1				
402	06/03/02	298	43.8	14.2	5.6U	7.7	5.6U	5.6U	5.1U			
403	06/04/02	201	5.5U	16	5.7U	5.5U	5.5U	5.2U			Not Sampled	
404	06/04/02	5.5U	5.4U	5.7	5.9U	5.7U	5.7U	10.0				
405	06/05/02	5.5	5.3U	5.6U	5.8U	5.9U	5.6U	14.6	8.1	5.3U		
406	06/05/02	68.6	5.2U	28.6	18.1	5.9U	5.6U	5.6U	5.9U			
407	06/06/02	487	215	78.9	5.6U	14.9	5.8U	5.7U	28.8	5.1U		
408	07/16/02	149	227	7.4	8.2	5.3U	5.2U	22.6	5.5U	5.5U	5.6U	
412	07/16/02	71.2	214	150	5.5U	5.6U	5.6U	38.3	32.8	17.9	5.9U	
415	06/06/02	122	16.5	17.5	5.5U	6U	5.6U	5.8U				
416	06/07/02	55.7	5.3U	78.4	5.4U	6U	5.2U	7.2	5.1U		Not Sampled	
417	06/07/02	5.6U	19.5	5.5U	5.6U	5.5U	5.5U	6.4U				
418	07/10/02	440	53.7	8	5.5U	5.3U	5.4U	5.9U	5.3U	6.3U	106	
419	07/11/02	5.3U	5.3U	56	5.6U	5.7U	5.7U	6U	5.4U	5.1U	11	
420	07/11/02	11	5.4U	47.7	16.3	13.7	5.7U	5.3U	5.4U	5.5U	5.5U	
421	07/11/02	12.8	24.6	11	31.1	6.6	5.6U	6.6U	5.9U	5.4U	5.6U	
423	07/15/02	25.1	32.9	181	34.4	5.6U	6.2U	12	5.8UJ	5.2U	6.3	
424	07/15/02	5.2U	84.2	7	5.2U	140						
430	07/17/02	230	324	25.4	5.9U	5.6U	5.4U	5.3U	6.1U	6U		
431	07/17/02	208	437	16.1	7.5	5.3U	5.5U	5.4U	5.1U	5.8U		
432	07/17/02	260	513	78R	11	18	31.4	5.3U	5.2U	5.9U		
433	07/18/02	431	321	17.4	30.6	15.2	11	5.1U	5.2U	5.3U	Not Sampled	
434	07/18/02	23.2	5.4U	68.7	14.5	6.1U	5.7U	5.8U	5.7U	5.2U		
435	07/18/02	142	12.6	11.9	9.7	5.1U	5.2U	5.6U	6.1U	5.9U		
436	07/10/02	5.5U	5.4U									
441	07/08/02	175	33	6U	32	5.8U	5.3U	5.2U	5.3U	5.2U		
442	07/09/02	5.7U	119R	39	5.6U	5.6U	8.2	5.1U	6.2U	5.3U	6.7U	
443	07/10/02	6U	17.2	5.3U	5.8U	6.2U	5.2U	5.2U	6.3U	6U	11.3	5.3U

Table 2-1 (continued)
Subsurface Soil PCE Results - Former Buildings 180/181 Area
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Borehole Number	Date Samples Collected	Sample Number/Sample Interval Depth Range (Results in ug/kg)										
		SB01 1 to 4 ft bgs	SB02 4 to 8 ft bgs	SB03 8 to 12 ft bgs	SB04 12 to 16 ft bgs	SB05 16 to 20 ft bgs	SB06 20 to 24 ft bgs	SB07 24 to 28 ft bgs	SB08 28 to 32 ft bgs	SB09 32 to 36 ft bgs	SB10 36 to 40 ft bgs	SB11 40 to 44 ft bgs
444	05/22/02	6.1U	5.5U	5.7U	5.7U	6.9U	5.5U	5.4U	6.1UR	5.4UR		
445	07/08/02	5.7U	5.6U	5.4U	5.9U	5.7U	5.7U	5.4U	6.2U	5.7U		
446	07/23/02	**38.9**	**17.6**	5.6U	5.6U	**7.4**	**27.1**	5.8U	5.3U	5.8U		
447	07/23/02	**21.5**	**36**	5.6U	5.5U	5.7U	**13.4**	5.8U	5.8U			
448	07/24/02	**54.9**	**10.9**	5.7U	5.7U	**8.7**	5.5U	5.9U	5.7U			
449	07/24/02	**69.4**	**12**	5.5U	5.5U	5.5U	**11.7**	6U	5.1U		Not Sampled	
450	07/25/02	**56.1**	5.5U	5.4U	5.2U	5.6U	5.8U	5.7U				
451	07/25/02	5.1U	5.3U	5.2U	5.5U							
452	07/25/02	5.6U	5.2U	5.2U	5.2U							

ug/kg = micrograms per kilogram
PCE = Tetrachloroethylene
U = Compound not detected above detection limit.
213 = Detected
R = Result was rejected during QC evaluation.
J = Estimated
431 = Result above the Kansas Department of Health and Environment RSK level of 180 ug/kg for the soil to groundwater protection pathway.
bgs = below ground surface

Table 2-2
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	**DCF92-01/01** 10/4/2005 05100233	**DCF92-05/01** 10/4/2005 05100229	**DCF93-13/01** 10/4/2005 05100230	**DCF93-19/01** 10/4/2005 05100231	**DCF93-20/01** 10/5/2005 05100257	**DCF06-25/01** 9/30/2005 05091901
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	0.5 U	***9.9***	***2.4***	***32.5***	***10.7***
Tetrachloroethylene	ug/L	5	0.5 U	***8.4***	***26.5***	0.5 U	***1.1***	***58.3***
Trichloroethylene	ug/L	5	0.5 U	0.5 U	***20.6***	0.5 U	***4.8***	***6.6***
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	***1.7***	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment
* = No established MCL or KSWQS
Shaded - Greater than MCL or KSWQS
Bold, italics - Compound was detected
RSK - Risk Based Screening Criteria

MCL - Maximum Contaminant Level
U - Compound was not detected
μg/L - micrograms per liter

Table 2-2
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	**DCF96-27/01**	**DCF00-34c/01**	**DCF96-36/01**	**DCF99-37c/01**	**DCF99-38c/01**	**DCF06-40/01**
Date Sampled:		RSK/MCL	9/30/2005	9/30/2005	9/29/2005	9/29/2005	9/29/2005	10/4/2005
Laboratory Number:			05091896	05091898	05091838	05091840	05091842	05100234
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***29.5***	***1.5***	0.5 U	***0.6***	***1.5***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***10***	0.5 U	***80.2***
Trichloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***1***	0.5 U	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment
* = No established MCL or KSWQS
Shaded - Greater than MCL or KSWQS
Bold, italics - Compound was detected
RSK - Risk Based Screening Criteria

MCL - Maximum Contaminant Level
U - Compound was not detected
µg/L - micrograms per liter

Table 2-2
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	**DCF02-41/01**	**DCF02-43/01**	**DCF02-44a/01**	**DCF02-44c/01**	**DCF02-46a/01**	**DCF02-46c/01**
Date Sampled:		RSK/MCL	10/3/2005	9/30/2005	10/4/2005	10/4/2005	10/3/2005	10/3/2005
Laboratory Number:			05100044	05091902	05100227	05100228	05100047	05100046
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***74.3***	0.5 U	***7.1***	***7.9***	***0.7***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	0.5 U	***45.3***	***51.5***	***1.5***	0.5 U
Trichloroethylene	ug/L	5	***5.3***	0.5 U	***6.8***	***6.8***	***0.7***	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

* = No established MCL or KSWQS

Shaded - Greater than MCL or KSWQS

Bold, italics - Compound was detected

RSK - Risk Based Screening Criteria

MCL - Maximum Contaminant Level

U - Compound was not detected

µg/L - micrograms per liter

Table 2-2
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-47a/01	DCF02-47c/01	DCF02-48a/01	DCF02-48c/01	DCF02-49c/01	DCF03-50c/01
Date Sampled:		RSK/MCL	10/3/2005	10/3/2005	9/30/2005	9/30/2005	9/30/2005	9/29/2005
Laboratory Number:			05100048	05100049	05091900	05091899	05091897	05091839
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***14.3***	0.5 U	***7***	***0.8***	***6.1***	0.5 U
Tetrachloroethylene	ug/L	5	***1.5***	***3.6***	***1***	***10.3***	***26.3***	0.5 U
Trichloroethylene	ug/L	5	***1.2***	0.5 U	***1.4***	***1***	***4.3***	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

* = No established MCL or KSWQS

Shaded - Greater than MCL or KSWQS

Bold, italics - Compound was detected

RSK - Risk Based Screening Criteria

MCL - Maximum Contaminant Level

U - Compound was not detected

µg/L - micrograms per liter

Table 2-2
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	**B354-99-11c/01**
Date Sampled:		RSK/MCL	9/29/2005
Laboratory Number:			05091843
Volatiles	**Units**		
cis-1,2-Dichloroethylene	ug/L	70	***2.8***
Tetrachloroethylene	ug/L	5	***11.2***
Trichloroethylene	ug/L	5	***1.8***
Vinyl Chloride	ug/L	2	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment
* = No established MCL or KSWQS
Shaded - Greater than MCL or KSWQS
Bold, italics - Compound was detected
RSK - Risk Based Screening Criteria

MCL - Maximum Contaminant Level
U - Compound was not detected
µg/L - micrograms per liter

Ta -1
Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
VI-1	1/31/2006	5	shallow	40	150		
		8	shallow	50			
		11	shallow	60			
		14	intermediate	30	70		
		17	intermediate	40			
		20	deep	80	245		Lifted tip 4" twice due to high pressure
		23	deep	80			
		26	deep	85			
		28	saturated	98	98		
				Total	563	363	
VI-2	2/1/2006	5	shallow	80	240		
		8	shallow	80			
		11	shallow	80			
		14	intermediate	35	70		
		17	intermediate	35			
		20	deep	50	150		
		23	deep	50			
		26	deep	50			
				Total	460	296	
VI-3	2/1/2006	6	shallow	31	245		Daylighted
		8	shallow	134			
		11	shallow	80			
		14	intermediate	45	90		
		17	intermediate	45			
		20	deep	70	210		
		23	deep	70			
		26	deep	70			
				Total	545	351	
VI-4	2/2/2006	5	shallow	0	0		Daylighted
		7	shallow	0			Daylighted
VI-4 (offset)	2/2/2006	5	shallow	0	0		Daylighted
		7	shallow	0			Daylighted
				Total	0	0	

Table 3-1
Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
VI-5	2/2/2006	8	shallow	160	240		
		11	shallow	80			
		14	intermediate	5	11		Daylighted
		15	intermediate	1			Daylighted
		17	intermediate	5			Daylighted
		20	deep	141	172		
		23	deep	25			Lifted tip 4" due to high pressure. Then daylighted.
		26	deep	6			Lifted tip due to high pressure. No flow.
		28	saturated	6	12		Lifted tip due to high pressure. No flow.
		30	saturated	6			Lifted tip due to high pressure. No flow.
				Total	435	280	
VI-6	2/2/2006	5	shallow	0	10		Daylighted
		7	shallow	0			Daylighted
		9	shallow	10			Daylighted
		12	shallow	0			Daylighted
		15	intermediate	5	5		Daylighted
		20	deep	200	200		
		23	deep	0			Daylighted
		25.5	deep	0			Probe refusal at 25.5 feet. Daylighted.
				Total	215	138	
VI-7	2/2/2006	28	saturated	35	35		Daylighted
		25	deep	0	370		Daylighted
		24	deep	235			
		21	deep	135			
		18	intermediate	5	14		Daylighted
		15	intermediate	9			Daylighted
		12	shallow	5	11		Daylighted
		9	shallow	3			Daylighted
		6	shallow	3			Daylighted
				Total	430	277	

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Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
VI-8	2/3/2006	6	shallow	9	16.6		Daylighted
		7	shallow	1.5			Daylighted
		9	shallow	2.5			Daylighted
		11	shallow	2.3			Daylighted
		12	shallow	1.3			Daylighted
		15	intermediate	64	66		Daylighted
		17	intermediate	2			Daylighted
		20	deep	148	449		
		22	deep	169			
		24	deep	132			
				Total	532	342	
VI-9	2/3/2006	6	shallow	90	376		
		8	shallow	80			
		10	shallow	126			
		12	shallow	80			
		14	intermediate	60	174		
		16	intermediate	60			
		18	intermediate	54			
				Total	550	354	
VI-10	2/27/2006	5	shallow	0	0		Daylighted
		8	shallow	0			Daylighted
		10	shallow	0			Daylighted
		12	shallow	0			Daylighted
		15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	0	0		Daylighted
		30	saturated	550	550		
				Total	550	354	
VI-11	2/27/2006	5.5	shallow	200	550		Daylighted
		7.5	shallow	0			
		11	shallow	350			
				Total	550	354	

Table 3-1
Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
VI-12	2/28/2006	5.5	shallow	0	350		Daylighted
		8	shallow	0			Daylighted
		11	shallow	350			
		15	intermediate	0	200		Daylighted
		18	intermediate	200			
				Total	550	354	
VI-13	2/28/2006	5.5	shallow	0	0		Daylighted
		8	shallow	0			Daylighted
		11	shallow	0			Daylighted
		15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	182	182		
		24	deep	0			Daylighted
		27	saturated	0	0		Daylighted
		30	saturated	0			Daylighted
				Total	182	117	
VI-14	2/28/2006	5	shallow	120	361		Balance remaining from VI-13
		12	shallow	241			
				Total	361	233	
VI-14	3/1/2006	12	shallow	550	550		
				Total	550	354	
VI-15	3/1/2006	15	intermediate	550	550		
				Total	550	354	
VI-16	3/1/2006	7	shallow	450	450		
		15	intermediate	100	100		
				Total	550	354	
VI-17	3/1/2006	7	shallow	0	0		Daylighted
		9	shallow	0			Daylighted
		12	shallow	0			Daylighted
		15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	0	550		
		24	deep	550			
				Total	550	354	

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Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
VI-18	3/2/2006	7	shallow	0	185		Daylighted
		9	shallow	185			
		15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	0	0		Daylighted
		24	deep	0			Daylighted
		27	saturated	365	365		
				Total	550	354	
VI-19	3/2/2006	7	shallow	15	21		Daylighted
		9	shallow	6			Daylighted
		15	intermediate	5	10		Daylighted
		18	intermediate	5			Daylighted
		21	deep	8	8		Daylighted
		24	deep	0			Daylighted
		27	saturated	519	519		
				Total	558	359	
VI-20	3/2/2006	15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	0	550		Daylighted
		24	deep	550			
				Total	550	354	
VI-21	3/2/2006	15	intermediate	0	0		Daylighted
		18	intermediate	0			Daylighted
		21	deep	0	0		Daylighted
		24	deep	0			Daylighted
		27	saturated	0	550		Daylighted
		30	saturated	550			
				Total	550	354	
VI-22	3/3/2006	27	saturated	550	550		
				Total	550	354	
VI-23	3/3/2006	27	saturated	60	590		Daylighted
		30	saturated	30			Daylighted
		32	saturated	500			
				Total	590	380	

Table 3-1
Vadose Zone Sodium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	Injection Interval	3% NaMnO4 Volume Injected (gallons)	3% NaMnO4 Volume Injected by Interval (gallons)	NaMnO4 Mass (pounds)	Comments
				Grand Total	11,471	7,388	

$NaMnO_4$ - Sodium Permanganate
Daylighted - NaMnO4 came to the surface due to low permeability at the injection interval
bgs - below ground surface
" - Inch
% - Percent

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
03/15/06	Cap 18 Not Injected	DCF06-25	-------	---	---	---	---	---	---	---	---	---	---
		DCF92-05	-------	---	---	---	---	---	---	---	---	---	---
		DCF93-13	-------	---	---	---	---	---	---	---	---	---	---
		DCF02-41	-------	---	---	---	---	---	---	---	---	---	---
		DCF06-40	-------	---	---	---	---	---	---	---	---	---	---
	NaMno4/ KMnO4	DCF02-42	14:20	Present	Present	---	---	---	---	---	---	---	---
		PSPZ1	-------	Not	Installed	---	---	---	---	---	---	---	---
		DCF96-25	-------	Not	Injected	---	---	---	---	---	---	---	---
04/18/06	Cap 18 Not Injected	DCF06-25	-------	---	---	---	---	---	---	---	---	---	---
		DCF92-05	-------	---	---	---	---	---	---	---	---	---	---
		DCF93-13	-------	---	---	---	---	---	---	---	---	---	---
		DCF02-41	-------	---	---	---	---	---	---	---	---	---	---
		DCF06-40	-------	---	---	---	---	---	---	---	---	---	---
	NaMno4/ KMnO4	DCF02-42		Present	Not Present	---	---	---	---	---	---	---	---
		PSPZ1	-------	Not	Installed	---	---	---	---	---	---	---	---
		DCF96-25	-------	Not	Injected	---	---	---	---	---	---	---	---
05/19/06	Cap 18 Not Injected	DCF06-25	-------	---	---	---	---	---	---	---	---	---	---
		DCF92-05	-------	---	---	---	---	---	---	---	---	---	---
		DCF93-13	-------	---	---	---	---	---	---	---	---	---	---
		DCF02-41	-------	---	---	---	---	---	---	---	---	---	---
		DCF06-40	-------	---	---	---	---	---	---	---	---	---	---
	NaMno4/ KMnO4	DCF02-42	8:40	Present	Not Present	---	---	---	---	---	---	---	---
		PSPZ1	8:40	Present	Not Present	---	---	---	---	---	---	---	---
		DCF96-25	8:40	Present	Not Present	---	---	---	---	---	---	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
07/24/06	Cap 18	DCF92-05	16:30	---	---	300	6.48	13.55	1.542	-75.8	2.95	---	---
			16:32	---	---	300	5.96	13.06	1.393	-59.5	2.14	---	---
			16:35	---	---	300	5.59	12.73	1.401	-44.0	2.85	---	---
			16:37	---	---	300	5.65	12.96	1.396	-42.5	3.90	---	---
			16:40	---	---	300	5.73	12.99	1.397	-41.0	3.70	0.60	0.60
		DCF93-13	15:55	---	---	100	6.70	18.09	1.767	18.1	6.01	---	---
			15:57	---	---	100	6.22	17.60	1.751	33.5	6.29	---	---
			16:00	---	---	200	6.14	17.45	1.709	-11.5	5.42	---	---
			16:02	---	---	200	6.15	17.60	1.615	-47.5	4.14	---	---
			16:05	---	---	200	6.17	17.73	1.554	-66.5	3.30	3.00	4.00
		DCF02-41	18:45	---	---	300	6.78	14.19	1.360	-20.0	2.67	---	---
			18:47	---	---	300	6.69	13.90	1.361	-35.7	1.84	---	---
			18:50	---	---	300	6.64	13.83	1.361	-44.8	1.57	---	---
			18:52	---	---	300	6.66	13.84	1.361	-51.2	1.45	---	---
			18:55	---	---	300	6.67	13.84	1.360	-59.1	1.37	7.00	8.00
		DCF06-40	17:55	---	---	200	6.79	20.80	1.632	28.6	2.74	---	---
			17:57	---	---	200	6.16	17.49	1.612	51.2	2.51	---	---
			18:00	---	---	200	6.25	17.35	1.627	46.4	2.41	---	---
			18:02	---	---	200	6.31	17.39	1.632	41.7	2.18	---	---
			18:05	---	---	200	6.31	17.27	1.633	40.1	2.08	0.10	0.10
	NaMno4/ KMnO4	DCF02-42	14:43	Present	Not Present	---	---	---	---	---	---		
		PSPZ1	14:50	Present	Not Present	---	---	---	---	---	---	---	---
		DCF96-25	14:55	Abandoned	Abandoned	---	---	---	---	---	---	---	---

Tal -2
Post-Injection Perfoımance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
08/23/06	Cap 18	DCF92-05	11:05	---	---	200	6.45	15.05	1.366	38.80	5.77	---	---
			11:07	---	---	200	6.66	14.60	1.346	1.10	2.89	---	---
			11:10	---	---	200	6.79	14.35	1.323	-21.90	2.08	---	---
			11:12	---	---	200	6.80	14.40	1.319	-29.30	2.26	---	---
			11:15	---	---	200	6.81	14.45	1.321	-31.90	1.97	0.60	1.00
		DCF93-13	10:42	---	---	300	6.63	15.44	1.352	-26.70	2.90	---	---
			10:44	---	---	300	6.91	15.10	1.241	-77.30	1.00	---	---
			10:47	---	---	300	7.00	14.98	1.212	-97.80	0.63	---	---
			10:49	---	---	300	7.03	14.91	1.206	-107.50	0.47	---	---
			10:52	---	---	300	7.04	14.90	1.206	-113.50	0.40	7.00	8.00
		DCF02-41	11:52	---	---	200	6.52	16.89	1.356	92.4	0.15	---	---
			11:54	---	---	200	6.99	15.00	1.330	-44.7	1.21	---	---
			11:57	---	---	200	7.01	14.90	1.322	-66.3	1.10	---	---
			11:59	---	---	200	7.03	14.90	1.320	-68.4	1.09	---	---
			12:02	---	---	200	7.04	14.84	1.319	-70.8	1.08	5.00	7.00
		DCF06-40	11:25	---	---	200	6.83	21.28	1.824	38.9	2.16	---	---
			11:27	---	---	200	6.84	20.60	1.802	41.8	1.50	---	---
			11:30	---	---	200	6.85	20.34	1.790	42.9	1.28	---	---
			11:32	---	---	200	6.85	20.15	1.783	42.7	1.16	---	---
			11:35	---	---	200	6.86	20.15	1.780	41.8	1.10	0.00	0.30
	NaMno4/ KMnO4	DCF0242	12:20	Present	Not Present	---	---	---	---	---	---		
		PSPZ1	13:10	Present	Not Present	---	---	---	---	---	---	---	---
		DCF06-25	13:20	Present	Present	---	---	---	---	---	---	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
09/05/06	Cap 18	DCF92-05	15:55	---	---	300	6.52	17.77	1.655	-27.8	7.59	---	---
			15:57	---	---	300	6.28	14.81	1.716	-59.1	2.55	---	---
			16:00	---	---	300	6.32	14.43	1.726	-94.0	1.69	---	---
			16:02	---	---	300	6.30	14.26	1.721	-124.2	1.58	---	---
			16:05	---	---	300	6.33	14.19	1.720	-136.3	1.73	0.10	0.20
		DCF93-13	16:18	---	---	350	6.09	16.04	1.473	-24.4	6.46	---	---
			16:20	---	---	350	6.20	15.22	1.562	-220.4	2.58	---	---
			16:23	---	---	350	6.34	15.07	1.639	-241.8	1.04	---	---
			16:25	---	---	350	6.39	14.98	1.653	-254.1	0.67	---	---
			16:28	---	---	350	6.43	14.83	1.634	-261.3	0.53	2.00	3.00
		DCF02-41	14:57	---	---	300	6.43	17.60	1.615	59.8	7.05	---	---
			14:59	---	---	300	6.80	15.46	1.609	-2.4	3.00	---	---
			15:02	---	---	300	7.01	15.03	1.608	-41.9	1.45	---	---
			15:04	---	---	300	6.86	14.81	1.598	-82.7	0.76	---	---
			15:07	---	---	300	6.90	14.75	1.597	-91.9	0.67	5.00	6.00
		DCF06-40	15:31	---	---	175	6.72	20.90	1.944	-46.0	3.25	---	---
			15:33	---	---	200	6.69	18.80	1.955	-77.1	2.41	---	---
			15:36	---	---	200	6.62	18.30	1.963	-82.1	2.20	---	---
			15:38	---	---	200	6.57	17.93	1.946	-88.8	1.71	---	---
			15:41	---	---	200	6.51	17.61	1.954	-91.1	1.49	0.00	0.10
	NaMno4/ KMnO4	DCF02-42	16:43	Present	Not Present	---	---	---	---	---	---	---	---
		PSPZ1	16:50	Present	Present	---	---	---	---	---	---	---	---
		DCF06-25	17:00	Present	Present	---	---	---	---	---	---	---	---

Ta[illegible]-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
10/02/06	Cap 18	DCF92-05	15:33	---	---	125	6.93	16.37	1.803	105.5	7.28	---	---
			15:38	---	---	125	6.62	16.40	1.791	68.1	4.28	---	---
			15:43	---	---	125	6.65	16.36	1.777	41.7	3.37	---	---
			15:48	---	---	125	6.59	16.14	1.773	31.4	4.02	---	---
			15:53	---	---	125	6.59	16.04	1.777	17.7	3.64	---	---
			15:58	---	---	125	6.64	15.83	1.779	-25.8	3.61	---	---
			16:03	---	---	125	6.77	15.67	1.777	-47.3	3.55	---	---
			16:08	---	---	125	6.83	15.64	1.774	-58.4	3.51	---	---
			16:12	---	---	125	6.87	15.63	1.773	-64.1	3.47	---	---
			16:17	---	---	125	6.89	15.61	1.772	-66.1	3.48	0.18	
10/03/06		DCF93-13	11:49	---	---	175	6.73	17.84	1.813	-30.1	7.65	---	---
			11:54	---	---	150	6.75	16.90	1.890	-87.5	3.45	---	---
			11:59	---	---	150	6.79	16.78	1.879	-119.7	2.66	---	---
			12:04	---	---	150	6.81	17.00	1.846	-132.1	2.58	---	---
			12:09	---	---	150	6.83	17.03	1.847	-130.7	2.64	---	---
			12:14	---	---	150	6.83	17.10	1.850	-132.1	2.57	0.03	---
		DCF06-40	10:38	---	---	150	6.60	20.53	2.084	120.8	2.88	---	---
			10:43	---	---	150	6.61	18.50	2.083	111.5	1.98	---	---
			10:48	---	---	150	6.73	17.73	2.077	91.0	1.61	---	---
			10:53	---	---	150	6.76	17.65	2.072	79.3	1.49	---	---
			10:58	---	---	150	6.77	17.66	2.070	70.3	1.32	---	---
			11:03	---	---	150	6.78	17.70	2.071	66.8	1.29	---	---
			11:08	---	---	150	6.77	17.78	2.068	59.2	1.33	---	---
			11:13	---	---	150	6.78	17.94	2.067	57.1	1.26	0.56	---
10/04/06		DCF02-41	7:43	---	---	250	6.56	16.39	1.687	85.5	7.32	---	---
			7:48	---	---	200	6.34	14.96	1.699	5.4	2.75	---	---
			7:53	---	---	200	6.65	14.63	1.691	-55.6	0.81	---	---
			7:58	---	---	150	6.77	14.75	1.690	-65.6	0.57	---	---
			8:03	---	---	150	6.80	14.77	1.694	-67.0	0.48	---	---
			8:08	---	---	150	6.82	14.75	1.697	-68.1	0.39	---	---
			8:13	---	---	150	6.82	14.74	1.699	-70.1	0.32	---	---
			8:18	---	---	150	6.84	14.75	1.700	-71.4	0.30	3.11	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
10/06/06	NaMno4/ KMnO4	DCF02-42	8:15	---	Present	---	---	---	---	---	---	---	---
		PSPZ1	-------	---	---	---	---	---	---	---	---	---	---
		DCF06-25	9:29	Present	Not Present	---	---	---	---	---	---	---	---
11/06/06	Cap 18	DCF92-05	14:32	---	---	300	6.34	14.88	1.787	-17.6	6.30	---	---
			14:35	---	---	300	6.63	14.32	1.816	-189.6	2.67	---	---
			14:37	---	---	300	6.62	14.18	1.818	-196.4	3.54	---	---
			14:40	---	---	300	6.68	14.14	1.820	-201.6	3.45	---	---
			14:42	---	---	300	6.72	14.10	1.817	-194.7	4.50	8.00	4.00
		DCF93-13	15:12	---	---	300	6.40	14.85	1.741	-194.6	4.75	---	---
			15:15	---	---	300	6.59	14.44	1.906	-223.1	2.74	---	---
			15:17	---	---	300	6.68	14.30	1.903	-219.3	3.63	---	---
			15:20	---	---	300	6.72	14.24	1.871	-231.9	3.99	---	---
			15:22	---	---	300	6.75	14.21	1.834	-242.2	3.32	0.10	0.20
		DCF02-41	15:35	---	---	400	6.48	14.42	1.619	-169.9	4.22	---	---
			15:37	---	---	400	6.79	14.31	1.618	-195.7	0.80	---	---
			15:40	---	---	400	6.92	14.33	1.608	-208.3	0.44	---	---
			15:42	---	---	400	6.92	14.34	1.617	-211.5	0.34	---	---
			15:45	---	---	400	6.92	14.34	1.621	-212.4	0.30	4.50	4.50
		DCF06-40	14:52	---	---	200	6.51	17.01	1.960	-164.9	3.83	---	---
			14:55	---	---	200	6.54	16.22	1.989	-189.3	1.86	---	---
			14:57	---	---	200	6.66	15.98	2.000	-190.9	1.60	---	---
			15:00	---	---	200	6.72	15.93	2.001	-193.7	1.37	---	---
			15:02			200	6.74	15.94	1.999	-197.7	1.24	0.00	0.20
	NaMno4/ KMnO4	DCF02-42		Present	Not Present	---	---	---	---	---	---	---	---
		PSPZ1		Present	Present	---	---	---	---	---	---	---	---
		DCF06-25		Present	Present	---	---	---	---	---	---	---	---

Ta[illegible]-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
12/06/06	Cap 18	DCF92-05	11:47	---	---	800	7.13	13.70	1.769	-60.4	1.23		
			11:50	---	---	300	7.00	13.65	1.769	-70.4	0.94		
			11:53	---	---	300	6.82	13.79	1.765	-67.0	0.75		
			11:56	---	---	300	6.80	13.82	1.766	-69.9	0.71		
			11:59	---	---	300	6.90	13.90	1.767	-86.2	0.58	10.0	0.00
		DCF93-13	0:27	---	---	600	7.08	14.20	1.718	-12.0	7.18		
			0:30	---	---	200	6.75	13.62	1.764	-16.8	8.89		
			12:46	---	---	200	6.93	12.31	2.409	-41.1	8.80		
			12:49	---	---	200	6.98	12.32	1.794	-47.6	2.38		
			12:52	---	---	200	7.01	13.82	1.711	-40.2	1.54	0.6	0.60
		DCF02-41	12:19	---	---	---	7.18	12.42	1.526	-39.8	7.55		
			13:22	---	---	300	7.19	13.70	1.538	-90.0	4.45		
			13:25	---	---	300	7.20	13.65	1.532	-93.9	3.74		
			13:28	---	---	300	7.18	13.65	1.528	-96.3	2.84		
			13:31	---	---	300	7.18	13.50	1.540	-97.3	2.79	4.0	0.00
		DCF06-40	12:07	---	---	200	6.81	13.81	1.885	-8.0	7.33		
			12:10	---	---	200	6.79	13.94	1.895	-5.7	2.82		
			12:13	---	---	200	6.88	14.14	1.906	-7.2	2.09		
			12:16	---	---	200	6.95	14.21	1.905	-22.4	2.01		
			12:19	---	---	200	6.99	14.25	1.903	-19.9	1.55	0.6	0.20
	NaMno4/ KMnO4	DCF02-42		Present	Present	---	---	---	---	---	---	---	---
		PSPZ1	---	Present	Present	---	---	---	---	---	---	---	---
		DCF06-25		Present	Present	---	---	---	---	---	---	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
06/19/07	None	DCF92-01*	16:30	---	---	200	6.65	20.70	1.675	209.7	8.70	---	---
			16:35	---	---	200	6.31	18.63	1.678	215.3	5.39	---	---
			16:40	---	---	200	6.32	18.15	1.704	194.0	4.17	---	---
			16:45	---	---	200	6.39	17.87	1.673	169.3	3.92	---	---
			16:50	---	---	200	6.46	17.78	1.697	154.1	3.67	---	---
			16:55	---	---	300	6.47	17.20	1.698	144.6	3.45	---	---
			17:00	---	---	300	6.46	17.13	1.700	135.5	3.30	---	---
			17:05	---	---	300	6.20	17.04	1.587	127.4	3.64	---	---
			17:10	---	---	300	6.07	17.04	1.625	124.3	3.36	---	---
			17:15	---	---	300	6.07	17.02	1.670	123.3	3.11	---	---
			17:20	---	---	300	6.07	17.02	1.694	117.9	2.95	---	---
			17:25	---	---	300	6.07	17.02	1.707	115.1	2.85	---	---
	Cap 18	DCF92-05	---	---	---	---	---	---	---	---	---	---	---
		DCF93-13	18:57	---	---	300	6.58	15.26	2.116	-51.0	1.55	---	---
			19:02	---	---	300	6.64	15.32	2.142	-55.4	1.64	---	---
			19:07	---	---	300	6.64	15.24	2.145	-58.3	1.02	---	---
			19:12	---	---	300	6.63	15.24	2.141	-61.5	0.58	---	---
			19:17	---	---	300	6.61	14.97	2.120	-64.0	0.39	---	---
			19:22	---	---	300	6.65	15.33	2.130	-68.9	0.43	---	---
			19:27	---	---	300	6.63	15.25	2.106	-70.4	0.28	---	---
			19:32	---	---	300	6.62	15.23	2.082	-72.9	0.03	---	---
			19:37	---	---	300	6.58	15.60	2.091	-73.9	0.03	---	---
		DCF02-41	---	---	---	---	---	---	---	---	---	---	---
		DCF06-40	17:40	---	---	150	6.67	20.37	1.782	125.8	6.69	---	---
			17:45	---	---	150	6.59	18.50	1.714	112.9	2.44		
			17:50	---	---	150	6.58	17.90	1.687	101.2	1.05		
			17:55	---	---	150	6.58	17.78	1.681	93.6	0.82		
			18:00	---	---	150	6.58	17.68	1.680	88.1	0.65	---	---
			18:05	---	---	150	6.58	17.63	1.678	82.5	0.56	---	---
			18:10	---	---	150	6.58	17.59	1.679	78.2	0.53	---	---
			18:15	---	---	150	6.58	17.63	1.678	75.6	0.48	---	---
	NaMno4/ KMnO4	DCF02-42	---	---	---	---	---	---	---	---	---	---	---
		PSPZ1	---	---	---	---	---	---	---	---	---	---	---
		DCF06-25	---	---	---	---	---	---	---	---	---	---	---

Tab[illegible]-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
0718/07	Cap 18	DCF92-05	11:36	---	---	300	6.69	15.41	2.182	-60.1	8.41	---	---
			11:41	---	---	300	6.57	14.42	2.247	-113.2	2.01	---	---
			11:46	---	---	300	6.63	14.36	2.253	-124.4	1.61	---	---
			11:51	---	---	300	6.66	14.37	2.246	-124.9	1.53	---	---
			11:56	---	---	300	6.66	14.33	2.222	-122.6	1.21	---	---
			12:01	---	---	300	6.66	14.29	2.209	-122.7	1.10	---	---
			12:06	---	---	300	6.66	14.30	2.188	-125.5	0.91	---	---
			12:11	---	---	300	6.66	14.60	2.175	-129.2	0.84	---	---
			12:16	---	---	300	6.66	14.69	2.164	-129.2	0.78	---	---
			12:21	---	---	300	6.67	14.36	2.153	-129.5	0.61	---	---
			12:26	---	---	300	6.67	14.35	2.133	-130.5	0.55	---	---
			12:31	---	---	300	6.69	14.37	2.123	-130.9	0.56	---	---
		DCF93-13	14:18	---	---	300	6.54	15.97	2.740	-162.9	3.93	---	---
			14:23	---	---	300	6.57	15.46	2.715	-196.1	1.12	---	---
			14:28	---	---	300	6.58	15.41	2.658	-201.9	0.85	---	---
			14:33	---	---	300	6.60	15.59	2.606	-206.2	0.73	---	---
			14:38	---	---	300	6.60	16.75	2.551	-209.4	0.69	---	---
			14:43	---	---	300	6.61	17.06	2.534	-212.8	0.81	---	---
			14:48	---	---	300	6.65	15.64	2.471	-218.2	0.55	---	---
			14:53	---	---	300	6.62	15.88	2.463	-222.2	0.45	---	---
			14:58	---	---	300	6.64	15.80	2.438	-225.0	0.43	---	---
			15:03	---	---	300	6.65	16.00	2.419	-226.6	0.46	---	---
		DCF02-41	15:22	---	---	300	6.98	15.76	1.590	-86.0	7.82	---	---
			15:27	---	---	300	6.90	15.36	1.605	-108.4	3.60	---	---
			15:32	---	---	300	6.89	14.97	1.610	-123.8	1.84	---	---
			15:37	---	---	300	6.88	14.96	1.611	-126.1	1.28	---	---
			15:42	---	---	300	6.88	14.90	1.613	-127.0	0.83	---	---
			15:47	---	---	300	6.88	14.89	1.613	-129.2	0.61	---	---
			15:52	---	---	300	6.88	14.87	1.613	-129.9	0.49	---	---
			15:57	---	---	300	6.88	14.82	1.614	-129.0	0.37	---	---
			16:02	---	---	300	6.88	14.86	1.612	-130.0	0.31	---	---
			16:07	---	---	300	6.88	14.87	1.611	-126.5	0.28	---	---
			16:12	---	---	300	6.88	14.82	1.611	-128.9	0.29	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
07/18/07	Cap 18	DCF06-40	12:58	---	---	150	6.53	19.70	1.895	44.4	3.13	---	---
			13:03	---	---	150	6.61	19.10	1.895	38.0	1.26	---	---
			13:08	---	---	150	6.63	18.91	1.896	32.9	0.68	---	---
			13:13	---	---	150	6.64	18.91	1.898	29.7	0.58	---	---
			13:18	---	---	150	6.65	18.81	1.899	26.5	0.43	---	---
			13:23	---	---	150	6.65	18.81	1.899	22.1	0.43	---	---
			13:28	---	---	150	6.72	18.85	1.898	-8.5	0.41	---	---
			13:33	---	---	150	6.70	18.79	1.899	-4.1	0.35	---	---
			13:38	---	---	150	6.67	18.82	1.900	-1.2	0.27	---	---
			13:43	---	---	150	6.63	18.75	1.903	4.8	0.29	---	---
			13:48	---	---	150	6.67	18.74	1.904	2.1	0.23	---	---
			13:53	---	---	150	6.65	18.71	1.903	1.0	0.24	---	---
			13:58	---	---	150	6.65	18.67	1.903	-0.8	0.24	---	---
	NaMno4/ KMnO4	DCF02-42	---	Present	Present	---	---	---	---	---	---	---	---
		PSPZ1		Present	Present	---	---	---	---	---	---	---	---
		DCF06-25		Present	Present	---	---	---	---	---	---	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)
08/23/07	Cap 18	DCF92-05	11:05	---	---	200	6.45	15.05	1.366	38.8	5.51		
			11:07	---	---	200	6.66	14.60	1.346	1.1	2.89		
			11:10	---	---	200	6.79	14.35	1.323	-21.9	2.08		
			11:12	---	---	200	6.80	14.40	1.319	-29.3	2.26		
			11:15	---	---	200	6.81	14.49	1.321	-31.9	1.97	0.6	1.00
		DCF93-13	10:42	---	---	300	6.63	15.44	1.352	-26.7	2.90		
			10:44	---	---	300	6.91	15.10	1.241	-77.3	1.00		
			10:47	---	---	300	7.00	14.98	1.212	-97.8	0.63		
			10:49	---	---	300	7.03	14.91	1.206	-107.5	0.47		
			10:52	---	---	300	7.04	14.90	1.206	-113.4	0.40	0.6	0.60
		DCF02-41	11:52	---	---	200	6.52	16.89	1.396	92.4	0.15		
			11:54	---	---	200	6.99	15.00	1.330	-44.7	1.21		
			11:57	---	---	200	7.01	14.90	1.322	-66.3	1.10		
			11:59	---	---	200	7.03	14.90	1.320	-68.4	1.09		
			12:02	---	---	200	7.04	14.84	1.319	-70.8	1.08	5.0	7.00
		DCF06-40	11:25	---	---	200	6.83	21.28	1.824	38.9	2.16		
			11:27	---	---	200	6.84	20.60	1.802	41.8	1.50		
			11:30	---	---	200	6.85	20.34	1.790	42.9	1.28		
			11:32	---	---	200	6.85	20.15	1.783	42.7	1.16		
			11:35	---	---	200	6.86	20.15	1.780	41.8	1.10	0.0	0.30
	NaMno4/ KMnO4	DCF02-42	---	Present	Present	---	---	---	---	---	---	---	---
		PSPZ1		Present	Present	---	---	---	---	---	---	---	---
		DCF06-25		Present	Present	---	---	---	---	---	---	---	---

Table 3-2
Post-Injection Performance Monitoring
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Treatment	Well ID	Time	Permanganate	Manganese Dioxide	Flow Rate (ml/min)	pH	Temperature (deg C)	Conductivity (mmhos/cm)	ORP (mV)	Dissolved Oxygen (mg/L)	Fe Ferrous (mg/L)	Fe Total (mg/L)

-- Measurement not required
$KMnO_4$ - Potassium Permanganate
$NaMnO_4$ - Sodium Permanganate
DCF - Dry Cleaning Facility
PSPZ - Pilot Study Piezometer
Fe - Iron
ORP - Oxidation Reduction Potential

* - Stabilization confirmation
ID - Well Identification
ml/min - Milliliters per minute
Deg C - Degrees Celsius
mmhos/cm - micromhos per centimeter
mV - Millivolt
mg/L - Milligram per Liter

Not all measurements were required during each monitoring event.
The post-injection performance monitoring for the vadose zone ($NaMnO_4$) and AOC 3 ($KMnO_4$) were combined.

Table 3-3
Sampling and Analytical Requirements
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Well ID	Formation Screened	GW Level	Analytical Laboratory Services						
			Manganese	TCL Volatiles	Methane, Ethane, Ethene	Alkalinity	TOC	Natural Attenuation(1)	Field Parameters (2)
DCF92-01	Upper Crouse	1	1	1	1	1	1	1	1
DCF92-05*	Unconsolidated	1	1	1	1	1	1	1	1
DCF93-08	Upper Crouse	1	1	1	1	1	1	1	1
DCF93-13*	Unconsolidated	1	1	1	1	1	1	1	1
DCF93-19	Lower Crouse	1	1	1	1	1	1	1	1
DCF93-20	Lower Crouse	1	1	1	1	1	1	1	1
DCF06-25	Alluvial	1	Not Sampled - Permanganate in well**						
DCF96-27	Alluvial	1	1	1	1	1	1	1	1
DCF00-34c	Alluvial	1	1	1	1	1	1	1	1
DCF96-36	Alluvial	1	1	1	1	1	1	1	1
DCF99-37c	Alluvial	1	1	1	1	1	1	1	1
DCF99-38c	Alluvial	1	1	1	1	1	1	1	1
DCF06-40*	Unconsolidated	1	1	1	1	1	1	1	1
DCF02-41*	Transition Zone	1	1	1	1	1	1	1	1
DCF02-42	Alluvial	1	Not Sampled - Permanganate in well**						
DCF02-43	Alluvial	1	1	1	1	1	1	1	1
DCF02-44a	Alluvial	1	1	1	1	1	1	1	1
DCF02-44c*	Alluvial	1	1	1	1	1	1	1	1
DCF02-46a	Alluvial	1	1	1	1	1	1	1	1
DCF02-46c	Alluvial	1	1	1	1	1	1	1	1
DCF02-47a	Alluvial	1	1	1	1	1	1	1	1
DCF02-47c	Alluvial	1	1	1	1	1	1	1	1
DCF02-48a	Alluvial	1	1	1	1	1	1	1	1
DCF02-48c	Alluvial	1	1	1	1	1	1	1	1
DCF02-49c*	Alluvial	1	1	1	1	1	1	1	1
DCF03-50c	Alluvial	1	1	1	1	1	1	1	1
354-99-11c*	Alluvial	1	1	1	1	1	1	1	1

(1) Natural Attenuation includes chloride, nitrate, sulfate and sulfide.

(2) Field parameters include pH, specific conductance, temperature, DO, ORP, turbidity, Fe III, and total Fe.

* - Wells sampled for Reduced Groundwater Sampling Events

** - Does not include baseline groundwater sampling events.

Table 3-4
High Pressure Subsurface Potassium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	$KMnO_4$ Injected (pounds)	Slurry Water Used (gallons)	Water Jet Water Used (gallons)	Chase Water Used (gallons)	Comments
FRX-1	4/21/2006	29.5	500	110	25	30	North of Union Pacific Railroad Grade
		Total	500	110	25	30	Water Column less than 2 feet
FRX-2	4/21/2006	29.75	500	70	20	25	North of Union Pacific Railroad Grade
		Total	500	70	20	25	Water Column less than 2 feet
FRX-4	4/23/2006	28	250	70	20	120	
		23	250	65	27	40	
		Total	500	135	47	160	
FRX-3	4/23/2006	28	250	35	30	20	
		23	250	45	30	40	
		Total	500	80	60	60	
FRX-8	4/24/2006	28	250	50	18	15	
		23	250	85	18	40	
		Total	500	135	36	55	
FRX-5	4/24/2006	28	250	70	20	20	
		23	250	55	20	20	
		Total	500	125	40	40	
FRX-9	4/24/2006	27	250	40	27	20	
		22	250	45	27	40	
		Total	500	85	54	60	
FRX-6 (off set)	4/24/2006	27	250	60	27	10	
		22	250	80	45	60	
		Total	500	140	72	70	
FRX-7	4/25/2006	28	300	50	35	20	
		23	320	40	45	40	
		Total	620	90	80	60	
FRX-11	4/25/2006	27	250	60	40	20	
		22	250	40	50	40	
		Total	500	100	90	60	
FRX-12	4/25/2006	28	250	50	30	26	
		23	310	50	40	40	
		Total	560	100	70	66	
FRX-10	4/25/2006	28	250	62.5	40	40	
		23	250	62.5	40	40	
		Total	500	125	80	80	

Table 3-4
High Pressure Subsurface Potassium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	$KMnO_4$ Injected (pounds)	Slurry Water Used (gallons)	Water Jet Water Used (gallons)	Chase Water Used (gallons)	Comments
FRX-13	4/25/2006	27	250	50	40	40	
		22	250	50	40	40	
		Total	500	100	80	80	
FRX-14	4/25/2006	28	250	NR	NR	NR	
		23	70	NR	NR	NR	
		Total	320	0	0	0	
FRX-16	4/26/2006	28	250	75	40	20	
		23	250	75	40	40	
		Total	500	150	80	60	
FRX-17	4/26/2006	27	250	62.5	35	40	
		22	250	62.5	35	40	
		Total	500	125	70	80	
FRX-18	4/26/2006	27	250	52.5	30	40	
		22	250	52.5	35	40	
		Total	500	105	65	80	
FRX-19	4/26/2006	28	250	57.5	35	40	
		23	250	57.5	35	60	
		Total	500	115	70	100	
FRX-20	4/27/2006	27	250	62.5	250	20	
		22	250	62.5	250	20	
		Total	500	125	500	40	
FRX-21	4/27/2006	28	250	62.5	40	20	
		23	250	62.5	40	40	
		Total	500	125	80	60	
FRX-15	4/27/2006	27	250	50	60	20	
		22	250	50	75	20	
		Total	500	100	135	40	
FRX-22	4/27/2006	28	250	100	45	40	
		23	250	100	60	80	
		Total	500	200	105	120	
FRX-23	4/27/2006	27	250	50	55	40	
		22	250	50	350	35	
		Total	500	100	405	75	

Ta' 3-4
High Pressure Subsurface Po. sium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	$KMnO_4$ Injected (pounds)	Slurry Water Used (gallons)	Water Jet Water Used (gallons)	Chase Water Used (gallons)	Comments
FRX-25	4/30/2006	27	250	60	60	20	
		22	250	65	35	40	
		Total	500	125	95	60	
FRX-27	4/30/2006	28	250	50	40	20	
		23	250	50	45	20	
		Total	500	100	85	40	
FRX-26	4/30/2006	27	250	52.5	45	20	
		22	250	52.5	45	40	
		Total	500	105	90	60	
FRX-28	4/30/2006	27	250	62.5	45	20	
		22	250	62.5	45	60	
		Total	500	125	90	80	
FRX-24	5/1/2006	28	250	62	60	20	
		23	250	63	60	20	
		Total	500	125	120	40	
FRX-29	5/1/2006	28	250	62.5	45	25	
		23	250	62.5	45	40	
		Total	500	125	90	65	
FRX-30	5/1/2006	27	250	77.5	35	40	
		22	250	77.5	35	70	
		Total	500	155	70	110	
FRX-35	5/1/2006	27	250	NR	NR	NR	
		22	250	NR	NR	NR	
		Total	500	0	0	0	
FRX-34	5/1/2006	27	250	87.5	40	40	
		22	250	87.5	40	60	
		Total	500	175	80	100	
FRX-33	5/1/2006	28	250	92.5	40	40	
		23	250	92.5	70	90	
		Total	500	185	110	130	
FRX-32	5/2/2006	27	250	90	20	50	
		22	250	90	0	100	
		Total	500	180	20	150	

Table 3-4
High Pressure Subsurface Potassium Permanganate Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Injection Location	Date	Injection Depth (feet bgs)	$KMnO_4$ Injected (pounds)	Slurry Water Used (gallons)	Water Jet Water Used (gallons)	Chase Water Used (gallons)	Comments
FRX-31	5/2/2006	28	250	100	20	50	
		23	250	100	0	125	
		Total	500	200	20	175	
FRX-36	5/2/2006	27	250	100	40	50	
		22	250	100	40	125	
		Total	500	200	80	175	
FRX-37	5/2/2006	28	250	100	40	40	
		23	250	100	40	140	
		Total	500	200	80	180	
FRX-38	5/2/2006	27	250	100	40	40	
		22	250	100	40	125	
		Total	500	200	80	165	
FRX-39	5/2/2006	28	250	87.5	40	40	
		23	250	87.5	40	100	
		Total	500	175	80	140	
FRX-43	5/2/2006	28	250	87.5	40	40	
		23	250	87.5	40	100	
		Total	500	175	80	140	
FRX-42	5/3/2006	27	250	87.5	40	40	
		22	250	87.5	40	100	
		Total	500	175	80	140	
FRX-41	5/3/2006	28	250	87.5	40	40	
		23	250	87.5	40	100	
		Total	500	175	80	140	
FRX-44	5/3/2006	25	250	87.5	40	40	
		20	250	87.5	40	100	
		Total	500	175	80	140	
FRX-40	5/3/2006	26	250	NR	NR	NR	
		21	25	NR	NR	NR	
		Total	275	0	0	0	
		Grand Totals	21,775	5,615	3,774	3,731	

Notes:
FRX - Injection location
bgs - below ground surface
NR - Not Recorded

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
5/9/2006	EAB-1	37 R	7.5	7.5	1100	1105	1.50	Refusal at ~37'bgs; injection totals corrected due to flow meter error
					1107	1118	0.68	
	EAB-2	35	2.5	7.5	1142	1144	1.25	Refusal at ~39' bgs; injection totals corrected due to flow meter error
		37	0		1146	NA	NA	
		39 R	5		1149	1150	5.00	
	EAB-3	36R	7.5	7.5	1212	1215	2.50	Refusal at ~36' bgs; injection totals corrected due to flow meter error
	EAB-4	35	2.5	15	1243	1246	0.83	Refusal at ~37' bgs
		37	2.5		1249	1250	2.50	
		37 R	10		1257	1303	0.22	
	EAB-5	35 R	15	15	1325	1330	3.00	Refusal at ~35' bgs
	EAB-6	37	5	15	1442	1446	1.25	Refusal at ~39' bgs
		39	5		1448	1450	2.50	
		39 R	5		1453	1454	5.00	
	EAB-7	33 R	0	0	NA	NA	NA	Refusal at ~33' bgs
5/10/2006	EAB-8	36	13	18	851	913	0.21	Refusal at ~39' bgs
		39 R	5		916	930	0.36	
	EAB-9	36	5	15	1100	1109	0.56	
		38	5		1115	1117	2.50	
		41	5		1122	1125	1.67	
	EAB-10	36	5	15	1200	1220	0.25	
		39	5		1223	1240	0.29	
		41	5		1243	1255	0.42	
	EAB-11	35	5	15	1357	1408	0.10	Noticed daylighting after 5 gal injected at 35' bgs; Daylighted immediately at 38' bgs
		38	0		1413	1415	0.00	
		41	10		1420	1425	2.00	
	EAB-12	37	5	15	1448	1455	0.71	Noticed daylighting after 5 gal injected at 40' bgs
		40	5		1500	1506	0.83	
		43	5		1509	1512	1.67	
	EAB-13	36	5	15	1536	1542	0.83	Noticed daylighting after 5 gal injected at 36' bgs
		39	5		1546	1550	1.25	
		41	5		1554	1555	5.00	
	EAB-14	37	5	15	1628	1633	1.00	Noticed daylighting after 2 gal injected at 40' bgs
		40	2		1636	1637	2.00	
		43	8		1639	1644	1.60	
	EAB-15	39	5	15	1703	1704	5.00	
		41	5		1706	1708	2.50	
		43	5		1710	1712	2.50	
	EAB-16	37	5	15	1735	1740	1.00	
		40	5		1743	1750	0.71	
		43	5		1753	1756	1.67	

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
5/11/2006	EAB-17	37	3	15	820	829	0.33	Noticed daylighting after 3 gal injected at 37' bgs & after 2 gal injected at 40' bgs
		40	2		833	835	1.00	
		43	10		838	843	2.00	
	EAB-18	37	5	15	916	923	0.71	
		40	5		926	933	0.71	
		43	5		936	940	1.25	
	EAB-19	37	5	15	1003	1015	0.42	Refusal at ~43' bgs
		40	5		1018	1021	1.67	
		43 R	5		1023	1025	2.50	
	EAB-20	37	5	15	1044	1056	0.42	
		40	5		1059	1110	0.10	
		43	5		1112	1116	1.25	
	EAB-21	37	5	12	1133	1142	0.56	Refusal at ~44' bgs; Noticed daylighting after injecting 5 gal at 40' bgs; Daylighted immediately at 43' bgs; Pulled back up to 37', daylighted again, ceased injection at EAB-21
		40	5		1145	1152	0.71	
		43	0		1154	NA	NA	
		44 R	2		1159	1200	0.05	
	EAB-22	37	5	15	1228	1233	1.00	Refusal at ~40' bgs
		40	5		1235	1237	2.50	
		40 R	5		1242	1244	2.50	
	EAB-23	37	5	15	1304	1307	1.67	Refusal at ~40' bgs
		40 R	10		1311	1314	3.33	
	EAB-24	37	5	15	1332	1340	0.63	
		40	5		1342	1359	0.29	
		43	5		1402	1404	2.50	
	EAB-25	37	5	15	1425	1428	1.67	
		40	5		1432	1436	1.25	
		43	5		1439	1444	1.00	
	EAB-26	37	3	5	1505	1508	1.00	Refusal at 40' bgs; Noticed daylighting after 3 gal injected at 37' bgs & after 2 gal injected at 40' bgs
		40 R	2		1512	1515	0.67	
	EAB-27	36	0	15	1539	NA	NA	Refusal at ~42' bgs; Formation not taking CAP-18 at 36' bgs & 37' bgs
		37	0		1545	NA	NA	
		40	10		1550	1606	0.18	
		42 R	5		1609	1611	2.50	
	EAB-28	37	5	15	1629	1632	1.67	Refusal at ~40' bgs
		40	5		1635	1636	5.00	
		40 R	5		1638	1639	5.00	
	EAB-29	37	5	15	1656	1658	2.50	Refusal at ~41' bgs
		40	5		1700	1702	2.50	
		41 R	5		1704	1705	5.00	

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
5/12/2006	EAB-30	37	5	15	900	902	2.50	
		40	5		904	910	0.83	
		43	5		914	925	0.45	
	EAB-31	37	5	15	947	954	0.71	
		40	5		956	1001	0.11	
		43	5		1004	1015	0.45	
	EAB-32	37	5	15	1034	1037	1.67	Refusal at ~40' bgs
		40 R	10		1040	1043	3.33	
	EAB-33	37	5	15	1003	1012	0.56	Refusal at ~39' bgs
		39 R	10		1115	1119	2.50	
5/15/2006	EAB-34	37	5	15	1017	1021	1.25	
		40	5		1023	1031	0.63	
		43	5		1034	1039	1.00	
	EAB-35	37	5	15	1109	1116	0.71	Noticed daylighting after 2 gal injected at 40' bgs; Formation not taking CAP-18 at 43' bgs
		40	2		1119	1121	1.00	
		43	0		1128		0.00	
		44	8		1134	1149	0.53	
	EAB-36	37	5	15	1210	1215	1.00	Refusal at ~42' bgs
		40	5		1217	1227	0.50	
		42 R	5		1230	1237	0.71	
	EAB-37	37	5	15	1304	1317	0.38	Refusal at ~40' bgs
		40 R	10		1322	1339	0.59	
	EAB-38	37	5	15	1420	1429	0.56	Refusal at ~41' bgs
		40	5		1431	1438	0.71	
		41 R	5		1441	1445	1.25	
	EAB-39	37	5	15	1505	1507	2.50	Refusal at ~42' bg
		40	5		1509	1512	1.67	
		42 R	5		1516	1518	2.50	
	EAB-40	37	5	15	1541	1543	2.50	
		40	5		1546	1556	0.50	
		43	5		1558	1605	0.11	

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
5/16/2006	EAB-41	37	5	15	907	910	1.67	Noticed daylighting after ~5 gal injected at ~43' bgs
		40	5		913	919	0.83	
		43	5		922	927	1.00	
	EAB-42	37	5	15	953	1002	0.10	Refusal at ~39' bgs
		39 R	10		1006	1014	1.25	
	EAB-43	37	5	15	1034	1050	0.31	Refusal at ~39' bgs
		39 R	10		1053	1057	2.50	
	EAB-44	37	5	15	1115	1121	0.83	
		40	5		1123	1130	0.71	
		43	5		1132	1137	1.00	
	EAB-45	37	5	15	1154	1200	0.11	
		40	5		1202	1206	1.25	
		43	5		1208	1212	1.25	
	EAB-46	37	5	15	1315	1321	0.83	Noticed daylighting after ~3 gal injected at ~40' bgs & after ~4 gal injected at ~43' bgs
		40	3		1322	1325	1.00	
		43	4		1327	1332	0.80	
		44	3		1334	1337	1.00	
	EAB-47	37	5	12	1357	1405	0.10	Refusal at ~42' bgs; Noticed Daylighting after ~2 gal injected at ~42' bgs
		40	5		1407	1418	0.45	
		42 R	2		1420	1426	0.33	
	EAB-48	37	5	15	1444	1451	0.71	
		40	5		1452	1457	1.00	
		43	5		1459	1503	0.11	
	EAB-49	37	5	15	1525	1534	0.56	
		40	5		1537	1544	0.71	
		43	5		1546	1552	0.83	
	EAB-50	37	5	15	1610	1620	0.50	
		40	5		1622	1627	1.00	
		43	5		1629	1633	1.25	

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
.7/2006	EAB-51	37	5	15	802	809	0.71	
		40	5		810	825	0.33	
		43	5		828	836	0.63	
	EAB-52	36 R	15	15	855	900	0.33	Refusal at ~36' bgs
	EAB-53	37	5	15	924	927	1.67	Offset due to rubble; Took plug out of injection tip to see if that would increase flow rate
		40	5		929	930	5.00	
		43	5		932	935	1.67	
	EAB-54	37	5	15	949	952	1.67	
		40	5		954	955	5.00	
		43	5		957	959	2.50	
	EAB-55	37	5	15	1014	1020	0.83	
		40	5		1022	1037	0.33	
		43	5		1040	1045	1.00	
	EAB-56	37	5	15	1107	1110	1.67	Refusal at ~43' bgs
		40	5		1112	1117	1.00	
		43 R	5		1120	1134	0.36	
	EAB-57	37	3	15	1149	1208	0.05	Refusal at ~39' bgs; Noticed daylighting after injecting ~3 gal at ~37' bgs
		39 R	12		1210	1233	0.52	
	EAB-58	37	5	15	1316	1324	0.63	Refusal at ~43' bgs
		40	5		1326	1333	0.71	
		43 R	5		1335	1339	1.25	
	EAB-59	37	5	15	1400	1402	2.50	
		40	5		1403	1405	2.50	
		43	5		1407	1408	5.00	
	EAB-60	37	5	15	1423	1435	0.42	
		40	5		1437	1440	1.67	
		43	5		1442	1443	5.00	
	EAB-61	37	5	15	1510	1512	2.50	Offset due to rubble
		40	5		1515	1518	1.67	
		43	5		1520	1522	2.50	
	EAB-62	37	5	15	1551	1553	2.50	Offset due to Rubble; Refusal at ~42' bgs
		40	5		1555	1600	0.11	
		42 R	5		1602	1616	0.36	
	EAB-63	35 R	15	15	1645	1651	2.50	Refusal at ~35' bgs

Table 3-5
EAB INJECTION
AOC 2
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date	Injection Location	Injection Interval (ft bgs)	Amount Injected (gal)	Total Amount Injected (gal)	Injection Time		Estimated Flow Rate (gpm)	Comments
					Start	Finish		
5/18/2006	EAB-64	37	5	15	811	813	2.50	
		40	5		815	817	2.50	
		43	5		819	834	0.33	
	EAB-65	37 R	15	15	908	917	1.67	Refusal at ~37' bgs
	EAB-66	37	5	20	1047	1052	1.00	
		40	10		1053	1107	0.19	
		43	5		1110	1117	0.71	
	EAB-67	37	10	20	1135	1139	2.50	Refusal at ~41' bgs
		40	5		1141	1144	1.67	
		41 R	5		1146	1149	1.67	
	EAB-68	37	2	20	1206	1210	0.50	Noticed daylighting after ~2 gal injected at ~37' bgs
		40	10		1212	1217	2.00	
		43	8		1219	1224	1.60	
	EAB-69	37	10	20	1244	1248	2.50	
		40	5		1251	1253	2.50	
		43	5		1256	1258	2.50	
	EAB-73	37	10	20	1320	1325	2.00	Noticed daylighting after injecting ~ gal at ~40' bgs
		40	5		1327	1331	1.25	
		43	5		1332	1334	2.50	
	EAB-71	37	5	20	1412	1419	0.71	
		40	5		1421	1426	1.00	
		43	10		1428	1440	0.83	
	EAB-70	37	10	20	1503	1506	3.33	Refusal at ~40' bgs
		40 R	10		1507	1512	2.00	
	EAB-72	37	5	16	1536	1538	2.50	Offset due to rubble
		40	6		1541	1545	1.50	
		43	5		1548	1550	2.50	
	Total by graduated stick (gal)		1080.5	1080.5				

Notes: EAB - Enhanced Anaerobic Bioremediation using Cap-18

gpm - gallons per minute — ft - Feet

lbs - pounds — R - Refusal

bgs - Below ground surface — Gal - Gallon

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
		Island Area		
9/12/06 1200	**Island** ***EAB-1***	13 14 15 17 17 21 25 29 33 37 40	36.0	High Pressure causing release @ pressure release valve on pump High Pressure causing release @ pressure release valve on pump High Pressure causing release @ pressure release valve on pump High Pressure causing release @ pressure release valve on pump Switched injection tips End @ 1410
9/12/06 1453	**Island** ***EAB-2***	13 17 21 25 29 33 37 40	36.0	End @ 1526
9/13/06 0843	**Island** ***EAB-3***	13 17 21 25 29 33 37 38.5	33.0	Start injection with ~62.0 gallons in polytank. Flow meter appears to be substantially low compared to the tank volume. Will begin injecting based on tank volume, and compare to flowmeter volume. Refusal @ 38.5 ft bgs, End @ 0908

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
9/13/06 0934	**Island *EAB-4***	13	31.0	Start injection with ~40.0 gallons in polytank.
		17		
		21		
		25		
		29		
		33		
		37		
		40		End @ 1000
9/13/06 1035	**Island *EAB-5***	13	31.0	Start injection with ~32.0 gallons in polytank.
		17		
		21		
		25		
		29		
		33		
		37		
		37.5		Refusal @ 37.5 bgs, End @ 1100
9/13/06 1410	**Island *EAB-6***	13	31.0	Start injection with ~50.0 gallons in polytank.
		17		
		21		
		25		
		29		
		33		
		37		
		39		Refusal @ 39 ft bgs, End @ 1434
9/13/06 1503	**Island *EAB-7***	13	31.5	Start injection with ~32.0 gallons in polytank.
		17		
		21		
		25		
		29		
		33		
		36		Refusal @ 36 ft bgs, End @ 1530

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
9/14/06 0958	**Island *EAB-8***	13	30.0	Start injection with ~30.0 gallons in polytank
		17		
		21		
		25		
		29		
		33		
		37		Refusal @ 37 ft bgs, End @ 1029
9/14/06 1056	**Island *EAB-9***	13	30.0	Start injection with ~30.0 gallons in polytank
		17		
		21		
		25		
		29		
		33		
		35.5		Refusal @ 35.5 ft bgs, End @ 1122
9/14/06 1217	**Island *EAB-10***	13	30.0	Start injection with ~60.0 gallons in polytank
		17		Meter stopped reading altogether, cleaned after this interval
		21		Meter resumes working to a degree
		25		
		29		
		33		
		35		Refusal @ 35 ft bgs, End @ 1251
9/14/06 1316	**Island *EAB-11***	13	30.0	Start injection with ~30.0 gallons in polytank
		17		
		21		
		25		
		29		
		33		
		35.5		Refusal @ 35.5 ft bgs, End @ 1340
		Total	349.5	

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
Horse Corral 11C Area				
9/20/06 0914	**HC-11C EAB-1**	20 24 28 32 36 40	24.0	Start injection with ~48 gal in polytank End @ 0941
9/20/06 1003	**HC-11C EAB-2**	20 24 28 32 36 40	24.0	Start injection with ~24 gal in polytank End @ 1024
9/20/06 1108	**HC-11C EAB-3**	20 24 28 32 36 40	24.0	Start injection with ~48 gal in polytank End @ 1125
9/20/06 1141	**HC-11C EAB-4**	20 24 28 32 36 40	24.0	Start injection with ~24 gal in polytank End @ 1159
9/20/06 1246	**HC-11C EAB-5**	20 24 28 32 36 40	24.0	Start injection with ~48 gal in polytank End @ 1300

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
9/20/06 1322	**HC-11C EAB-6**	20	20.0	Start injection with ~25 gal in polytank
		24		
		28		
		32		
		36		
		40		End @ 1335
9/20/06 1412	**HC-11C EAB-7**	20	20.0	Start injection with ~40 gal in polytank
		24		
		28		
		32		
		36		
		40		End @ 1425
9/20/06 1440	**HC-11C EAB-8**	20	20.0	Start injection with ~20 gal in polytank
		24		
		28		
		32		
		36		
		40		End @ 1500
		Total	180.0	
Horse Corral 37C Area				
9/18/06 1117	**HC-37C EAB-1**	27	24.0	Start injection with ~65 gal in polytank
		31		
		35		
		39		
		43		Refusal @ 43 ft bgs, End @ 1142
9/18/06 1211	**HC-37C EAB-2**	27	24.0	Start injection with ~41 gal in polytank
		31		
		35		
		39		
		43		
		47		End @ 1233

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
9/18/06 1332	**HC-37C EAB-3**	27 31 35 39 43 47	24.0	Start injection with ~48 gal in polytank End @ 1353
9/18/06 1423	**HC-37C EAB-4**	27 31 35 39 43 47	24.0	Start injection with ~24 gal in polytank End @ 1447
9/19/06 0917	**HC-37C EAB-5**	27 31 35 39 43 47	24.0	Start injection with ~48 gal in polytank End @ 0942
9/19/06 1003	**HC-37C EAB-6**	27 31 35 39 43 47	24.0	Start injection with ~24 gal in polytank End @ 1034
9/19/06 1119	**HC-37C EAB-7**	27 31 35 39 43 47	24.0	Start injection with ~48 gal in polytank End @ 1143

Table 3-6
Other Areas
EAB Injection
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Date/Time	Injection Location	Injection Interval (ft bgs)	Total Amount Injected Estimated from Polytank (gallon)	Notes
9/19/06 1216	**HC-37C EAB-8**	27 31 35 39 43 47	24.0	Start injection with ~24 gal in polytank End @ 1240
		Total	192.0	
		Grand Total	721.5	

Notes:
ft bgs - Feet below ground surface
gal - Gallon

Table 4-1
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	**DCF92-01/01**	**DCF92-05/01**	**DCF93-13/01**	**DCF93-19/01**	**DCF93-20/01**	**DCF06-25/01**
Date Sampled:		RSK/MCL	10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/5/2005	9/30/2005
Laboratory Number:			05100233	05100229	05100230	05100231	05100257	05091901
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	0.5 U	***9.9***	***2.4***	***32.5***	***10.7***
Tetrachloroethylene	ug/L	5	0.5 U	***8.4***	***26.5***	0.5 U	***1.1***	***58.3***
Trichloroethylene	ug/L	5	0.5 U	0.5 U	***20.6***	0.5 U	***4.8***	***6.6***
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	***1.7***	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - RiskBased Standards

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-1
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF96-27/01	DCF00-34c/01	DCF96-36/01	DCF99-37c/01	DCF99-38c/01	DCF06-40/01
Date Sampled:		RSK/MCL	9/30/2005	9/30/2005	9/29/2005	9/29/2005	9/29/2005	10/4/2005
Laboratory Number:			05091896	05091898	05091838	05091840	05091842	05100234
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***29.5***	***1.5***	0.5 U	***0.6***	***1.5***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***10***	0.5 U	***80.2***
Trichloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***1***	0.5 U	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - RiskBased Standards

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-1
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF02-41/01 10/3/2005 05100044	DCF02-43/01 9/30/2005 05091902	DCF02-44a/01 10/4/2005 05100227	DCF02-44c/01 10/4/2005 05100228	DCF02-46a/01 10/3/2005 05100047	DCF02-46c/01 10/3/2005 05100046
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***74.3***	0.5 U	***7.1***	***7.9***	***0.7***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	0.5 U	***45.3***	***51.5***	***1.5***	0.5 U
Trichloroethylene	ug/L	5	***5.3***	0.5 U	***6.8***	***6.8***	***0.7***	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - RiskBased Standards

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-1
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-47a/01	DCF02-47c/01	DCF02-48a/01	DCF02-48c/01	DCF02-49c/01	DCF03-50c/01
Date Sampled:		RSK/MCL	10/3/2005	10/3/2005	9/30/2005	9/30/2005	9/30/2005	9/29/2005
Laboratory Number:			05100048	05100049	05091900	05091899	05091897	05091839
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***14.3***	0.5 U	***7***	***0.8***	***6.1***	0.5 U
Tetrachloroethylene	ug/L	5	***1.5***	***3.6***	***1***	***10.3***	***26.3***	0.5 U
Trichloroethylene	ug/L	5	***1.2***	0.5 U	***1.4***	***1***	***4.3***	0.5 U
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - RiskBased Standards

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-1
Positive Detections
Fall 2005 Baseline Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

	Sample Point:	KDHE	**B354-99-11c/01**
	Date Sampled:	RSK/MCL	9/29/2005
	Laboratory Number:		05091843
Volatiles	**Units**		
cis-1,2-Dichloroethylene	ug/L	70	***2.8***
Tetrachloroethylene	ug/L	5	***11.2***
Trichloroethylene	ug/L	5	***1.8***
Vinyl Chloride	ug/L	2	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - RiskBased Standards

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-2
Natural Attenuation Baseline for Field Parameters and Geochemical Data
Spring 2005 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions [1]	DCF92-01 4/18/2005	DCF92-05 4/15/2005	DCF93-13 4/15/2005	DCF93-19 4/18/2005	DCF93-20 4/18/2005	DCF06-25 4/14/2005	DCF96-27 4/13/2005
Sampling Stabilization Parameters [2]		Terrace	Terrace	Terrace	Bedrock	Bedrock	Alluvial	Alluvial
Temperature (°C)	> 20°C	16.3	11.9	14.4	16.6	16.9	14.7	13.3
pH (standard units)	5 < x < 9	**7.3**	**7.4**	**7.5**	**7.4**	**7.6**	**6.9**	**6.9**
Conductivity (umhos)	NAp	1120	1290	1460	1020	1440	1220	910
Turbidity (NTU)	NAp	2.1	14	9.7	23	6.7	28	60
Natural Attenuation Parameters								
Methane (ug/L)	> 500	2 U	2 U	2 U	**708**	3	2 U	42
Ethane (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Ethene (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	376	334	327	500	295	404	350
Total Organic Carbon (mg/L)	> 20	1.5	2.3	1.9	6.1	1.4	1.4	1.5
Nitrate, as N (mg/L)	< 1	3.4	2.6	2.7	**0.1 U**	**0.1**	2.9	**0.1**
Sulfate (mg/L)	< 20	116	81	96	32.4	552	123	96
Sulfide (mg/L)	>1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chloride (mg/L)	86[5]-140[6]	**287**	**339**	**408 J**	**192**	**324**	**409 J**	112
DO (mg/L) [2]	< 0.5	3.48	7.58	5.25	3.53	3.50	1.98	1.18
Oxidation/Reduction Potential (mV) [2]	< 50	113	134	75	**-84**	**-2**	**40**	**-20**
Ferrous Iron (mg/L) [2]	> 1	0.00	0.00	0.02	**1.94**	0.02	**2.92**	0.63

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice upland terrace aquifer (RIA, 2004)

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
µg/L - micrograms per liter
mV - millivolts
umhos - microohms

°C - degrees Celsius
DO - Dissolved Oxygen
NTU - Nephelometric Turbidity Units

J - Result estimated
U - Result not detected
R - Result rejected
Nap - Not Applicable

Table 4-2
Natural Attenuation Baseline for Field Parameters and Geochemical Data
Spring 2005 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF00-34c 4/13/2005	DCF96-36 4/12/2005	DCF99-37c 4/12/2005	DCF99-38c 4/12/2005	DCF06-40 4/15/2005	DCF02-41 4/13/2005	DCF02-42 4/18/2005
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	14.3	13.5	14.3	13.9	16.6	13.7	19.7
pH (standard units)	5 < x < 9	**7.2**	**6.9**	**7.0**	**7.4**	**7.6**	**7.0**	**7.3**
Conductivity (umhos)	NAp	1380	980	1110	890	1530	1160	1350
Turbidity (NTU)	NAp	200	12	1.7	9.8	1.0	11	2
Natural Attenuation Parameters								
Methane (ug/L)	> 500	12	2 U	2 U	92	2 U	2 U	2 U
Ethane (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Ethene (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	328	314	336	189	381	376	399
Total Organic Carbon (mg/L)	> 20	1.7	2.1	1.4	3	1.6	1.4	1.4 U
Nitrate, as N (mg/L)	< 1	**0.1 U**	**0.1 UR**	**0.1 U**	**0.1 U**	18.3	**0.1 U**	5
Sulfate (mg/L)	< 20	248	141	170	146	127	126	110
Sulfide (mg/L)	>1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chloride (mg/L)	86[5]-140[6]	**313**	128	**199**	**169**	**398 J**	**257**	**354**
DO (mg/L) (2)	< 0.5	**0.22**	1.02	**0.17**	**0.13**	5.72	0.51	1.41
Oxidation/Reduction Potential (mV) (2)	< 50	**-126**	51	**40**	**-130**	146	**-167**	90
Ferrous Iron (mg/L) (2)	> 1	**2.84**	0.11	0.00	**2.34**	0.03	**1.69**	0.07

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice upland terrace aquifer (RIA, 2004)

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
µg/L - micrograms per liter
mV - millivolts
umhos - microohms

°C - degrees Celsius
DO - Dissolved Oxygen
NTU - Nephelometric Turbidity Units
DCF 06-25 replaced DCF96-25
DCF 06-40 replaced DCF01-40

J - Result estimated
U - Result not detected
R - Result rejected
Nap - Not Applicable

Table 4-2
Natural Attenuation Baseline for Field Parameters and Geochemical Data
Spring 2005 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-43 4/15/2005	DCF02-44a 4/15/2005	DCF02-44c 4/15/2005	DCF02-46a 4/14/2005	DCF02-46c 4/14/2005	DCF02-47a 4/14/2005	DCF02-47c 4/14/2005
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	13.8	14.1	14.5	15.3	17.2	15.0	14.9
pH (standard units)	5 < x < 9	**7.5**	**7.4**	**7.4**	**7.1**	**7.0**	**7.0**	**7.0**
Conductivity (umhos)	NAp	790	1310	1300	800	820	1060	840
Turbidity (NTU)	NAp	26	0.3	0.4	1.0	1.8	0.6	10
Natural Attenuation Parameters								
Methane (ug/L)	> 500	2 U	2 U	2 U	4	2 U	10	2 U
Ethane (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Ethene (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Alkalinity, as $CaCO_3$ (mg/L)	816^3-698^4	315	418	408	373	386	415	368
Total Organic Carbon (mg/L)	> 20	0.7	2.1	1.4	1.7	0.9	2	0.9
Nitrate, as N (mg/L)	< 1	**0.9**	1.4	1.8	**0.6**	2.3	**0.3**	1.9
Sulfate (mg/L)	< 20	106	150	148	155	147	210	141
Sulfide (mg/L)	>1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chloride (mg/L)	86^5-140^6	73 J	**291 J**	**282 J**	90 J	86 J	122 J	83 J
DO (mg/L) (2)	< 0.5	5.02	**0.29**	**0.23**	1.40	2.10	0.61	1.90
Oxidation/Reduction Potential (mV) (2)	< 50	221	**-16**	95	106	101	152	141
Ferrous Iron (mg/L) (2)	> 1	0.20	0.27	0.15	0.06	0.42	0.13	0.22

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice upland terrace aquifer (RIA, 2004)

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
µg/L - micrograms per liter
mV - millivolts
umhos - microohms

°C - degrees Celsius
DO - Dissolved Oxygen
NTU - Nephelometric Turbidity Units

J - Result estimated
U - Result not detected
R - Result rejected
Nap - Not Applicable

Table 4-2
Natural Attenuation Baseline for Field Parameters and Geochemical Data
Spring 2005 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions (1)	DCF02-48a 4/13/2005	DCF02-48c 4/13/2005	DCF02-49c 4/13/2005	DCF03-50c 4/12/2005	B354-99-11c 4/12/2005
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	14.4	14.4	13.6	13.0	15.3
pH (standard units)	5 < x < 9	**7.1**	**7.0**	**7.0**	**7.1**	**7.0**
Conductivity (umhos)	NAp	1090	940	1260	1100	1250
Turbidity (NTU)	NAp	1.5	15	23	28	1.1
Natural Attenuation Parameters						
Methane (ug/L)	> 500	32	2 U	2 U	6	2 U
Ethane (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U
Ethene (ug/L)	> 10	4 U	4 U	4 U	4 U	4 U
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	329	361	426	317	343
Total Organic Carbon (mg/L)	> 20	2.5	1.2	1.9	2.1	1.3
Nitrate, as N (mg/L)	< 1	**0.1 U**	1.4	1.7	**0.1 U**	4.1
Sulfate (mg/L)	< 20	189	145	160	193	189
Sulfide (mg/L)	>1	0.3	0.1 U	0.1 U	0.1 U	0.1 U
Chloride (mg/L)	86[5]-140[6]	**169**	103	**207**	**175**	**250**
DO (mg/L) (2)	< 0.5	**0.17**	**0.28**	**0.38**	**0.15**	**0.18**
Oxidation/Reduction Potential (mV) (2)	< 50	**-134**	133	113	82	92
Ferrous Iron (mg/L) (2)	> 1	0.71	0.00	0.07	0.18	0.01

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice upland terrace aquifer (RIA, 2004)

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
µg/L - micrograms per liter
mV - millivolts
umhos - microohms

°C - degrees Celsius
DO - Dissolved Oxygen
NTU - Nephelometric Turbidity Units

J - Result estimated
U - Result not detected
R - Result rejected
Nap - Not Applicable

Table 4-3
VADOSE ZONE ASSESSMENT
MONITORING WELL DCF02-42
AOC 3 FIELD ANALYTICAL RESULTS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Location	Depth Interval (ft bgs)	PCE (µg/kg)	TCE (µg/kg)	cis-1,2-DCE (µg/kg)
TS-1	3-4	**6.3J**	ND	ND
TS-1	7-8	**2.2J**	ND	ND
TS-1	8-10	**2.9J**	ND	ND
TS-1	10-12	ND	ND	ND
TS-1	12-14	**8.3J**	ND	ND
TS-1	14-16	ND	ND	ND
TS-1	14-16	ND	ND	ND
TS-1	16-18	**31.3**	ND	ND
TS-1	18-20	ND	ND	ND
TS-1	20-22	ND	ND	ND
TS-1	22-24	**20.4**	ND	ND
TS-1	24-26	**12.3**	ND	ND

Notes:

PCE - Tetrachloroethylene

TCE - Trichlorothylene

cis-1,2-DCE - cis-1,2-dichloroethylene

ND - Not Detected

J - Estimated value below calibration range.

ft bgs - Feet below ground surface

KDHE - Kansas Department of Health and Environment

µg/kg - Microgram per kilogram

RSK - Risk Based Soil to Groundwater Protection Pathway

Bold - Analyte detected

KDHE Soil Residential RSK

PCE - 180 µg/kg

TCE - 200 µg/kg

cis-1,2-DCE - 800 µg/kg

Table 4-4
Excavation Confirmation Analytical Results
AOC 1
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Location	Depth Interval (ft bgs)	PCE (µg/kg)	TCE (µg/kg)	cis-1,2-DCE (µg/kg)	Vinyl Chloride (µg/kg)
Area 1 North	BW	7/8	**8.7**	ND	ND	ND
Area 1 South	BW	7/8	ND	ND	ND	ND
Area 2	BW	11/12	ND	ND	ND	ND
Area 1 North	EW	7/8	**14.1**	ND	ND	ND
Area 1 South	EW	7/8	ND	ND	ND	ND
Area 2	EW	7/8	102	ND	ND	ND
Area 1 North	NW	7/8	ND	ND	ND	ND
Area 1 South	NW	7/8	**21.4**	ND	ND	ND
Area 2	NW	7/8	ND	ND	ND	ND
Area 1 North	SW	7/8	**14.1**	ND	ND	ND
Area 1 South	SW	7/8	**69.7**	ND	ND	ND
Area 2	SW	11/12	ND	ND	ND	ND
Area 1 North	WW	7/8	**19.6**	ND	ND	ND
Area 1 South	WW	7/8	**33.9**	ND	ND	ND
Area 2	WW	7/8	**6.8**	ND	ND	ND

Notes:

PCE - Tetrachloroethylene ND - Not Detected

TCE - Trichlorothylene

cis-1,2-DCE - cis-1,2-dichloroethylene

RSK - Risk Based Soil to Groundwater Protection Pathway

µg/kg - Microgram per kilogram

ft bgs - Feet below ground surface

KDHE - Kansas Department of Health and Environment

Bold - Indicates analyte detected

KDHE Soil RSK

PCE - 180 µg/kg

TCE - 200 µg/kg

cis-1,2-DCE - 800 µg/kg

BW - Bottom Wall

EW - East Wall

NW - North Wall

SW - South Wall

Ta… 4-5
Excavation Toxicity Characteristic Leaching Procedure
Analytical Results
AOC 1
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Location	Depth Interval (ft bgs)	1,1-DCE	1,2-DCA	Benzene	Carbon Tetrachloride	CHB	CHF	MEK	PCE	TCE	VC
Area #1	BW	0/4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Area #2	BW	4/8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

ft bgs - Feet below ground surface
BW - Bottom Wall of excavation
ND - Not Detected above TCLP
1,1-DCE - 1,1-Dichloroethene
1,2-DCA - 1,2-Dichloroethane
CHB - Chlorobenzene
CHF - Chloroform

MEK - Methy Ethyl Ketone
PCE - Tetrachloroethylene
TCE - Trichlorothylene
VC - Vinyl Chloride

All results in milligrams per Liter

Table 4-6
Utility Corridor Excavation Analytical Results
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinly Chloride
Waste Piles	WP#1	**36.4**	ND	ND	*
	WP#2	**28**	ND	ND	*
	WP#3	ND	ND	ND	*
Utility Corridor MH 363 to MH 365	UC-01	ND	ND	ND	*
	UC-02	ND	ND	ND	*
	UC-03	ND	ND	ND	*
	UC-04	ND	ND	ND	*
	UC-05	ND	ND	ND	*
	UC-06	ND	ND	ND	*
	UC-07	ND	ND	ND	*
	UC-08	ND	ND	ND	*
	UC-09	**7.8J**	ND	ND	*
AGL Parallel to Custer Road	UC-07	***479 J***	ND	ND	*
	UC-08	**35.8**	ND	ND	*
	UC-09	**26.1**	ND	ND	*
	UC-10	**15.6**	ND	ND	*
	UC-11	**16.7**	ND	ND	*
	UC-12	ND	ND	ND	*
	UC-13	ND	ND	ND	*
	UC-14	ND	ND	ND	*
	UC-15	ND	ND	ND	*

Table 4-6
Utility Corridor Excavation Analytical Results
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinly Chloride
AGL Parallel to Custer Road	UC-16	ND	ND	ND	*
	UC-17	ND	ND	ND	*
	UC-18	ND	ND	ND	*
	UC-19	ND	ND	ND	*
	UC-20	ND	ND	ND	*
	UC-21	ND	ND	ND	*
	UC-22	ND	ND	ND	*
	UC-23	ND	ND	ND	*
	UC-24	ND	ND	ND	*
	UC-25	ND	ND	ND	*
	UC-26	ND	ND	ND	*
	UC-27	ND	ND	ND	*
	UC-28	ND	ND	ND	*
	UC-29	ND	ND	ND	*
	UC-30	ND	ND	ND	*
	UC-30A	**6.4J**	ND	ND	*
	UC-31	ND	ND	ND	*
	UC-32	ND	ND	ND	*
	UC-33	ND	ND	ND	*
	UC-34	ND	ND	ND	*

Table 4-6
Utility Corridor Excavation Analytical Results
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinly Chloride
AGL Parallel to Custer Road	UC-35	ND	ND	ND	*
	UC-36	ND	ND	ND	*
	UC-37	ND	ND	ND	*
	UC-38	ND	ND	ND	*
Utility Corridor Confirmation Sample Results	UC-05	ND	ND	ND	ND
	UC-08	ND	ND	ND	ND
	UC-09	**19.2**	ND	ND	ND
AGL Confirmation Sample Results	UC-07	***237***	ND	ND	ND
	UC-08	**28.8**	ND	ND	ND
	UC-11	**15.3**	ND	ND	ND
	UC-19	ND	ND	ND	ND
	UC-21	ND	ND	ND	ND
	UC-30A	**11.7**	ND	ND	ND
	UC-34	ND	ND	ND	ND
	UC-35	ND	ND	ND	ND

Notes:

ND - Not Detected

WP - Waste Pile

*- Not analyzed for

All results in µg/kg

µg/kg - Microgram per kilogram

Bold - Analyte detected

Bold - Analyte detected above KDHE RSK

KDHE Soil RSK

PCE - 180 µg/kg

TCE - 200 µg/kg

cis-1,2-DCE - 800 µg/kg

VC - 20 µg/kg

Table 4-7
Confirmation Analytical Results
Landfarm Treatment Cell
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinyl Chloride
Landfarm Treatment Cell Sampling Phase 1 Sampling Date 2/27/2006	LTC1/01	**36.8**	ND	ND	ND
	LTC1/02	**56.1**	ND	ND	ND
	LTC01/03	ND	ND	ND	ND
	LTC01/04	**17**	ND	ND	ND
	LTC01/05	**61**	ND	ND	ND
	LTC1/06	**50.9**	ND	ND	ND
	LTC1/07	**26.8**	ND	ND	ND
	LTC0/08	**16**	ND	ND	ND
	LTC1/09	**17**	ND	ND	ND
	LTC1/10	**18**	ND	ND	ND
	LTC1/11	**12**	ND	ND	ND
	LTC1/12	**36.6**	ND	ND	ND

Table 4-7
Confirmation Analytical Results
Landfarm Treatment Cell
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinyl Chloride
Landfarm Treatment Cell Sampling Phase 2 Sample Date 3/17/2006	LTC2/01	**29.5**	ND	ND	ND
	LTC2/02	**22.3**	ND	ND	ND
	LTC02/03	**14.2**	ND	ND	ND
	LTC2/04	**14.8**	ND	ND	ND
	LTC2/05	**31.4**	ND	ND	ND
	LTC2/06	**11.3**	ND	ND	ND
	LTC2/07	**16**	ND	ND	ND
	LTC2/08	**26.9**	ND	ND	ND
	LTC2/09	**6.6**	ND	ND	ND
	LTC2/10	ND	ND	ND	ND
	LTC2/11	ND	ND	ND	ND
	LTC2/12	ND	ND	ND	ND

Table 4-7
Confirmation Analytical Results
Landfarm Treatment Cell
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Area	Sample Identification	Tetrachloroethylene	Trichloroethylene	cis-1,2-Dichloroethylene	Vinyl Chloride
Landfarm Treatment Cell Sampling Phase 3 Sampling Date 4/04/2006	LTC3/01	**44.5**	ND	ND	ND
	LTC3/02	**36.6**	ND	ND	ND
	LTC3/03	**13.6**	ND	ND	ND
	LTC3/04	**16.1**	ND	ND	ND
	LTC3/05	**39.6**	ND	ND	ND
	LTC3/06	**29.2**	ND	ND	ND
	LTC3/07	**16.3**	ND	ND	ND
	LTC3/08	**25.4**	ND	ND	ND
	LTC3/09	**14.3**	ND	ND	ND
	LTC3/10	**19.1**	ND	ND	ND
	LTC3/11	**12.5**	ND	ND	ND
	LTC3/12	**75.1**	ND	ND	ND
Landfarm Leachate Sampling	Tank 1 Leachate	ND	ND	ND	ND
	Tank 2 Leachate	ND	ND	ND	ND
	Tank 3 Leachate	ND	ND	ND	ND

Notes:

ND - Not Detected

LTC - Landfarm Treatment Cell

All soil results in µg/kg

All leachate results in µg/L

ug/kg - Microgram per kilogram

L - Liter

Leachate sampling dates - 3/28/2006, 4/06/2006, and 4/10/2006

KDHE Soil RSK

PCE - 180 ug/kg

TCE - 200 ug/kg

cis-1,2-DCE - 800 ug/kg

VC - 20 ug/kg

BOLD - Analyte detection

Table 4-8
Positive Detections
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF92-01/01 3/31/2006 06032178	DCF92-05/01 3/31/2006 06032179	DCF93-13/01 3/31/2006 06032185	DCF93-19/01 3/31/2006 06032183	DCF93-20/01 3/31/2006 06032181	DCF06-25/01 3/31/2006 06032175
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	0.5 U	***2***	***3.4***	***23.7***	***10.3***
Tetrachloroethylene	ug/L	5	0.5 U	***5.9***	***28.7***	0.5 U	***0.5***	***62.4***
Trichloroethylene	ug/L	5	0.5 U	0.5 U	***6.7***	0.5 U	***3.6***	***6.8***
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	***2.4***	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-8
Positive Detections
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF96-27/01 3/29/2006 06031862	DCF00-34c/01 3/29/2006 06031863	DCF96-36/01 3/28/2006 06031774	DCF99-37c/01 3/28/2006 06031776	DCF99-38c/01 3/29/2006 06031860	DCF06-40/01 10/4/2005 05100234
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***25.6***	***1.7***	0.5 U	***8.4***	***0.8***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***3.7***	0.5 U	***78.1***
Trichloroethylene	ug/L	5	0.5 U	***0.5***	0.5 U	***0.8***	0.5 U	0.5 U
Vinyl Chloride	ug/L	2	***0.8***	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-8
Positive Detections
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF02-41/01 3/30/2006 06032027	DCF02-42/01 3/31/2006 06032182	DCF02-43/01 3/31/2006 06032174	DCF02-44a/01 3/31/2006 06032177	DCF02-44c/01 3/31/2006 06032176	DCF02-46a/01 3/30/2006 06032032
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***83.3***	***1.4***	0.5 U	***5.4***	***11.9***	0.5 U
Tetrachloroethylene	ug/L	5	0.5 U	***58.9***	0.5 U	***42.1***	***50.5***	0.5 U
Trichloroethylene	ug/L	5	**3.5**	***2.8***	0.5 U	***5.1***	***8***	***0.6***
Vinyl Chloride	ug/L	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-8
Positive Detections
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-46c/01	DCF02-47a/01	DCF02-47c/01	DCF02-48a/01	DCF02-48c/01	DCF02-49c/01
Date Sampled:		RSK/MCL	3/30/2006	3/30/2006	3/30/2006	3/30/2006	3/29/2006	3/29/2006
Laboratory Number:			06032033	06032031	06032030	06032029	06031865	06031864
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	***10.2***	0.5 U	**9.2**	***0.9***	***6.5***
Tetrachloroethylene	ug/L	5	0.5 U	***2.4***	2.5	**1.3**	***13.7***	***30.4***
Trichloroethylene	ug/L	5	0.5 U	***1.4***	0.5 U	**1.4**	***1.2***	***4.9***
Vinyl Chloride	ug/L	2	0.5 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-8
Positive Detections
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF03-50c/01	B354-99-11c/01
Date Sampled:		RSK/MCL	3/28/2006	3/28/2006
Laboratory Number:			06031773	06031775
Volatiles	**Units**			
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	***0.8***
Tetrachloroethylene	ug/L	5	0.5 U	***11.1***
Trichloroethylene	ug/L	5	0.5 U	***1***
Vinyl Chloride	ug/L	2	0.5 U	0.5 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-9
Field Parameters and Geochemical Data
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF92-01 03/31/2006	DCF92-05 03/31/2006	DCF93-08 (DRY)	DCF93-13 03/31/2006	DCF93-19 03/31/2006	DCF93-20 03/31/2006	DCF96-25 03/31/2006
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	16.42	11.28	NAp	15.43	16.35	13.18	14.73
pH (standard units)	5 < x < 9	**6.41**	**6.54**	NAp	**6.82**	**6.70**	**6.86**	**6.6**
Conductivity (umhos)	NAp	1655	2053	NAp	1816	1314	1851	1962
Turbidity (NTU)	NAp	1.04	3.49	NAp	2.67	8.99	13.6	11.80
Natural Attenuation Parameters								
Magnesium	NAp	39.2	27.4	NAp	30.1	45.3	54.6	51.4
Methane (ug/L)	> 500	ND	ND	NAp	ND	**925**	9	ND
Ethane (ug/L)	> 10	ND	ND	NAp	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	NAp	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	383	323	NAp	328	518	307	434.0
Total Organic Carbon (mg/L)	> 20	1.8	2.1	NAp	1.9	6.3	1.8	1.7
Nitrate, as N (mg/L)	< 1	3.9	2.9	NAp	2.7	**ND**	**0.2**	3.5
Sulfate (mg/L)	< 20	148	85.2	NAp	95	**16.2**	424.0	126.0
Sulfide (mg/L)	>1	ND	ND	NAp	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	**292**	**518**	NAp	**482**	**205**	**373**	**395.0**
DO (mg/L) (2)	< 0.5	1.89	7.15	NAp	5.19	1.92	3.49	3.20
Oxidation/Reduction Potential (mV) (2)	< 50	107.3	126.1	NAp	89.2	**32.4**	82.7	115.1
Ferrous Iron (mg/L) (2)	> 1	0.00	0.20	NAp	0.00	**3.15**	0.13	0.0

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

mg/L - milligrams per liter
mV - millivolts
µg/L - micrograms per liter
umhos - microohms
C - Celsius

Bold Shading indicates favorable geochemical conditions.

Table 4-9
Field Parameters and Geochemical Data
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions (1)	DCF96-27 03/29/2006	DCF00-34c 03/29/2006	DCF96-36 03/28/2006	DCF99-37c 03/28/2006	DCF99-38c 03/28/2006	DCF06-40 03/29/2006	DCF02-41 03/30/2006
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	14.65	15.28	13.62	14.91	14.14	15.47	14.49
pH (standard units)	5 < x < 9	**6.70**	**8.36**	**7.95**	**6.88**	**7.10**	**6.74**	**6.90**
Conductivity (umhos)	NAp	2502	3182.00	848	1254	2143	3473	1478
Turbidity (NTU)	NAp	28.3	425.00	38.1	1.05	21.2	1.84	12.8
Natural Attenuation Parameters								
Magnesium	NAp	37.0	51.4	23.7	36.7	22.4	45.2	50.8
Methane (ug/L)	> 500	90	35	4.0	ND	15	ND	ND
Ethane (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	474	386	331	342	231	394	3947
Total Organic Carbon (mg/L)	> 20	2.6	2.0	7.9	3	2.4	1.5	1.5
Nitrate, as N (mg/L)	< 1	**ND**	**ND**	**ND**	**ND**	**ND**	13.9	**ND**
Sulfate (mg/L)	< 20	99.6	266	120	173.0	166	112	137
Sulfide (mg/L)	>1	ND	1.0	0.2	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	132	**252**	51	**184**	**166**	**332**	**239**
DO (mg/L) (2)	< 0.5	1.88	1.34	6.66	2.41	3.86	4.31	**0.26**
Oxidation/Reduction Potential (mV) (2)	< 50	**-24.3**	**-91.50**	**-112.2**	88.6	**-89.3**	120.7	**18.4**
Ferrous Iron (mg/L) (2)	> 1	**1.97**	**2.60**	**1.01**	0.00	**3.06**	0.41	**2.90**

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NAp - Not Applicable
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NTU - Nephelometric Turbidity Units

mg/L - milligrams per liter
mV - millivolts
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umhos - microohms
C - Celsius

Bold Shading indicates favorable geochemical conditions.

Tab._ 4-9
Field Parameters and Geochemical Data
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-42 (Bailed Dry) 3/31/2006	DCF02-43 03/31/2006	DCF02-44a 03/31/2006	DCF02-44c 03/31/2006	DCF02-46a 03/30/2006	DCF02-46c 03/30/2006	DCF02-47a 03/30/2006
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	NAp	14.47	14.76	14.73	15.10	15.10	15.06
pH (standard units)	5 < x < 9	NAp	**6.77**	**6.47**	**6.62**	**6.87**	**6.87**	**6.80**
Conductivity (umhos)	NAp	NAp	1192	1907	1747	997	997	1281
Turbidity (NTU)	NAp	NAp	42.1	1.54	3.53	49.30	49.3	0.37
Natural Attenuation Parameters								
Magnesium	NAp	219.0	45.4	52.3	49.3	43.5	41.5	50.2
Methane (ug/L)	> 500	3.0	ND	ND	ND	ND	ND	16
Ethane (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	**1613**	381	440	422	407	353	420
Total Organic Carbon (mg/L)	> 20	14.3	1.1	3.1	1.7	1.4	1.0	1.8
Nitrate, as N (mg/L)	< 1	5.3	1.2	1.3	1.1	**0.8**	1.2	**0.6**
Sulfate (mg/L)	< 20	130.0	173	160	141	154	141	232
Sulfide (mg/L)	>1	ND	ND	ND	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	**381.0**	112	**363**	**323**	86	79	113
DO (mg/L) (2)	< 0.5	NAp	2.46	**0.43**	**0.24**	0.77	3.48	**0.33**
Oxidation/Reduction Potential (mV) (2)	< 50	NAp	120.2	73.6	107.7	106.0	119.2	107.2
Ferrous Iron (mg/L) (2)	> 1	NA	0.00	0.00	0.08	0.00	0.00	0.18

NOTES:
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DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

mg/L - milligrams per liter
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µg/L - micrograms per liter
umhos - microohms
C - Celsius

Bold Shading indicates favorable geochemical conditions.

Table 4-9
Field Parameters and Geochemical Data
Spring 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions [(1)]	DCF02-47c 03/30/2006	DCF02-48a 03/30/2006	DCF02-48c 03/29/2006	DCF02-49c 03/29/2006	DCF03-50c 03/28/2006	B354-99-11c 03/28/2006
Sampling Stabilization Parameters [(2)]							
Temperature (°C)	> 20°C	14.77	15.08	15.10	14.69	13.47	15.80
pH (standard units)	5 < x < 9	**6.85**	**6.89**	**6.83**	**7.17**	**7.13**	**8.50**
Conductivity (umhos)	NAp	1052	1202	2279	2779	1209	1620
Turbidity (NTU)	NAp	43.4	1.96	12.4	27.6	18.4	1.87
Natural Attenuation Parameters							
Magnesium	NAp	39.2	37.8	40.8	44.4	29.0	41.5
Methane (ug/L)	> 500	ND	17	ND	ND	5	ND
Ethane (ug/L)	> 10	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	374	376	393	420	269	353
Total Organic Carbon (mg/L)	> 20	0.9	2.2	1.2	1.7	2.0	1.3
Nitrate, as N (mg/L)	< 1	1.8	**ND**	1.5	1.5	**ND**	5.7
Sulfate (mg/L)	< 20	155	187	157	170	209	187
Sulfide (mg/L)	>1	ND	0.2	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	83	124	107	**186**	**183**	**305**
DO (mg/L) [(2)]	< 0.5	1.43	**0.15**	1.34	1.50	4.41	2.07
Oxidation/Reduction Potential (mV) [(2)]	< 50	109.2	**-35.1**	64.6	**47.7**	111.3	62.0
Ferrous Iron (mg/L) [(2)]	> 1	0.13	0.62	0.06	0.52	0.00	0.00

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
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C - Celsius

Bold Shading indicates favorable geochemical conditions.

Table 4-10
Positive Detections
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF92-01/01 10/2/2006 06100043	DCF92-05/01 10/2/2006 06100044	DCF93-13/01 10/3/2006 06100133	DCF93-19/01 10/3/2006 06100134	DCF93-20/01 10/3/2006 06100136	DCF96-27/01 10/4/2006 06100263
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	0.5 U	0.5 U	***4.5***	***23.3***	***11.8***
Tetrachloroethylene	ug/L	5	1.1 U	***5.7***	***9.6***	1.1 U	1.1 U	***2.5***
trans-1,2-Dichloroethylene	ug/L	100	0.5 U	0.5 U	**0.5**	0.5 U	0.5 U	0.5 U
Trichloroethylene	ug/L	5	**0.6**	0.6 U	***1.4***	0.6 U	0.6 U	***7.4***
Vinyl Chloride	ug/L	2	**0.8**	0.8 U	0.8 U	***2.9***	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

RSK - Risk Based Standards

MCL - Maximum Contaminant Level

U - Compound was not detected

µg/L - micrograms per liter

Table 4-10
Positive Detections
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	**DCF00-34c/01**	**DCF96-36/01**	**DCF99-37c/01**	**DCF99-38c/01**	**DCF02-41/01**	**DCF02-43/01**
Date Sampled:		RSK/MCL	10/4/2006	10/5/2006	10/3/2006	10/3/2006	10/4/2006	10/6/2006
Laboratory Number:			06100265	06100431	06100127	06100128	06100261	06100486
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***1***	0.5 QCU	***0.7***	0.5 U	***84.3***	0.5 U
Tetrachloroethylene	ug/L	5	1.1 U	1.1 QCU	***8.1***	1.1 U	1.1 U	1.1 U
trans-1,2-Dichloroethylene	ug/L	100	0.5 U	0.5 QCU	0.5 U	0.5 U	***1.2***	0.5 U
Trichloroethylene	ug/L	5	0.6 U	0.6 QCU	***0.9***	0.6 U	***2***	0.6 U
Vinyl Chloride	ug/L	2	0.8 U	0.8 QCU	0.8 U	0.8 U	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

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MCL - Maximum Contaminant Level

U - Compound was not detected

µg/L - micrograms per liter

Table 4-10
Positive Detections
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-44a/01	DCF02-44c/01	DCF02-46a/01	DCF02-46c/01	DCF02-47a/01	DCF02-47c/01
Date Sampled:		RSK/MCL	10/5/2006	10/5/2006	10/5/2006	10/5/2006	10/4/2006	10/4/2006
Laboratory Number:			06100432	06100434	06100435	06100436	06100267	06100268
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***4.7***	***9.1***	***0.8***	0.5 QCU	***11.4***	0.5 U
Tetrachloroethylene	ug/L	5	***33.4***	***45.1***	***1.2***	1.1 QCU	1.1 U	***2.3***
trans-1,2-Dichloroethylene	ug/L	100	0.5 QCU	0.5 QCU	0.5 QCU	0.5 QCU	0.5 U	0.5 U
Trichloroethylene	ug/L	5	***5.1***	***8.3***	***0.8***	0.6 QCU	0.6 U	0.6 U
Vinyl Chloride	ug/L	2	0.8 QCU	0.8 QCU	0.8 QCU	0.8QCU	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

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Bold, italics - Compound was detected

RSK - Risk Based Standards

MCL - Maximum Contaminant Level

U - Compound was not detected

μg/L - micrograms per liter

Table 4-10
Positive Detections
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-48a/01	DCF02-48c/01	DCF02-49c/01	DCF03-50c/01	DCF06-40/01	B354-99-11c/01
Date Sampled:		RSK/MCL	10/4/2006	10/4/2006	10/4/2006	10/5/2006	10/3/2006	10/3/2006
Laboratory Number:			06100269	06100270	06100264	06100430	06100130	06100129
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***7.9***	***0.7***	***5.8***	0.5 U	***1.2***	***2.1***
Tetrachloroethylene	ug/L	5	***1.3***	***11.1***	***24.3***	1.1 U	***61.2***	***9.2***
trans-1,2-Dichloroethylene	ug/L	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethylene	ug/L	5	***3.1***	***1.8***	***4***	0.6 U	0.6 U	***1.4***
Vinyl Chloride	ug/L	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

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RSK - Risk Based Standards

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U - Compound was not detected

μg/L - micrograms per liter

Tab. ‑11
Field Parameters and Geochemical Data
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF92-01 10/2/2006	DCF92-05 10/2/2006	DCF93-08 (DRY)	DCF93-13 10/3/2006	DCF93-19 10/3/2006	DCF93-20 10/3/2006	DCF06-25
Sampling Stabilization Parameters (2)		Terrace	Terrace	Bedrock	Terrace	Bedrock	Bedrock	Alluvial
Temperature (°C)	> 20°C	18.41	15.61	NA	17.10	19.45	18.50	NA
pH (standard units)	5 < x < 9	**6.76**	**6.89**	NA	**6.83**	**6.88**	**6.93**	NA
Conductivity (umhos)	NAp	1.753	1.772	NA	1.850	1.566	2.253	NA
Turbidity (NTU)	NAp	0.56	1.11	NA	2.15	12.9	1.17	NA
Natural Attenuation Parameters								
Manganese (mg/L)	NAp	ND	0.15	NA	0.66	0.66	0.05	NA
Methane (ug/L)	> 500	ND	41	NA	3	401	7	NA
Ethane (ug/L)	> 10	ND	ND	NA	ND	ND	ND	NA
Ethene (ug/L)	> 10	ND	ND	NA	ND	ND	ND	NA
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	386	403	NA	382	512	312	NA
Total Organic Carbon (mg/L)	> 20	1.7	2.4	NA	9.1	4.7	1.8	NA
Nitrate, as N (mg/L)	< 1	4.3	1.4	NA	**0.5**	**ND**	**ND**	NA
Sulfate (mg/L)	< 20	137	66	NA	97.0	**14.1**	471	NA
Sulfide (mg/L)	>1	ND	ND	NA	**1.4**	ND	ND	NA
Chloride (mg/L)	86[5]-140[6]	**270**	**311**	NA	**280**	**197**	**212**	NA
DO (mg/L) (2)	< 0.5	1	3.48	NA	2.57	2.62	3.50	NA
Oxidation/Reduction Potential (mV) (2)	< 50	1.8	**-66.1**	NA	**-132.1**	**-64.5**	**-61.7**	NA
Ferrous Iron (mg/L) (2)	> 1	0.02	0.18	NA	0.03	**3.26**	0.27	NA

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
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(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
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DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
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mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Table 4-11
Field Parameters and Geochemical Data
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF96-27 10/4/2006	DCF00-34c 10/4/2006	DCF96-36 10/5/2006	DCF99-37c 10/3/2006	DCF99-38c 10/3/2006	DCF06-40 10/3/2006	DCF02-41 10/4/2006
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	18.76	16.50	14.53	14.84	14.57	17.94	14.75
pH (standard units)	5 < x < 9	**6.81**	**7.10**	**6.90**	**6.90**	**7.31**	**6.78**	**6.84**
Conductivity (umhos)	NAp	1.401	1.727	1.094	1.437	1.733	2.067	1.700
Turbidity (NTU)	NAp	336	323	6.69	0.20	3.07	0.38	3.1
Natural Attenuation Parameters								
Manganese (mg/L)	NAp	1.15	1.31	2.19	0.31	1.25	ND	0.56
Methane (ug/L)	> 500	54	217	6	ND	23	ND	ND
Ethane (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	384	398	336	347	215	413	373
Total Organic Carbon (mg/L)	> 20	2.1	1.5	2	2	2.6	1.6	1.3
Nitrate, as N (mg/L)	< 1	**0.5**	**ND**	**ND**	3	**ND**	7.4	**ND**
Sulfate (mg/L)	< 20	118	247	120	126	246	103	123
Sulfide (mg/L)	>1	ND	ND	ND	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	**176**	**241**	59	**189**	**280**	**350**	**255**
DO (mg/L) (2)	< 0.5	1.63	**0.08**	**0.12**	1.49	**0.25**	1.26	**0.30**
Oxidation/Reduction Potential (mV) (2)	< 50	**-27.2**	**-140.2**	**-132.3**	78.2	**-112.6**	57.1	**-71.4**
Ferrous Iron (mg/L) (2)	> 1	0.02	**2.41**	**1.22**	0.11	0.06	0.56	**3.11**

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
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DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
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NTU - Nephelometric Turbidity Units
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Tab… -11
Field Parameters and Geochemical Data
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions (1)	DCF02-42 Permanganate	DCF02-43 10/6/2006	DCF02-44a 10/5/2006	DCF02-44c 10/5/2006	DCF02-46a 10/5/2006	DCF02-46c 10/5/2006	DCF02-47a 10/4/2006
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	Nap	14.46	14.84	15.11	15.73	15.55	14.80
pH (standard units)	5 < x < 9	Nap	**6.61**	**6.51**	**6.62**	**6.79**	**6.80**	**6.79**
Conductivity (umhos)	NAp	Nap	1.397	2.183	2.064	1.289	1.232	1.692
Turbidity (NTU)	NAp	Nap	21.0	10.60	1.41	1.43	4.2	0.65
Natural Attenuation Parameters								
Manganese (mg/L)	NAp	Nap	0.07	0.02	0.59	0.17	0.03	0.76
Methane (ug/L)	> 500	Nap	2.0	ND	ND	ND	ND	17
Ethane (ug/L)	> 10	Nap	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	Nap	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816^3-698^4	Nap	381	437	416	389	389	452
Total Organic Carbon (mg/L)	> 20	Nap	1.1	2.5	1.8	1.8	0.8	2.5
Nitrate, as N (mg/L)	< 1	Nap	1.3	2.2	1.5	**0.3**	**0.9**	**ND**
Sulfate (mg/L)	< 20	Nap	167	146	130	150	140	290
Sulfide (mg/L)	>1	Nap	ND	ND	ND	ND	ND	ND
Chloride (mg/L)	86^5-140^6	Nap	121	**340**	**310**	82	89	**141**
DO (mg/L) (2)	< 0.5	Nap	1.80	1.80	0.58	0.79	2.45	**0.18**
Oxidation/Reduction Potential (mV) (2)	< 50	Nap	54.4	54.4	**44.4**	**26.4**	**46.3**	**-1.5**
Ferrous Iron (mg/L) (2)	> 1	Nap	0.05	1.00	0.10	0.00	0.02	0.20

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Table 4-11
Field Parameters and Geochemical Data
Fall 2006 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions [(1)]	DCF02-47c 10/4/2006	DCF02-48a 10/4/2006	DCF02-48c 10/4/2006	DCF02-49c 10/4/2006	DCF03-50c 10/5/2006	B354-99-11c 10/3/2006
Sampling Stabilization Parameters [(2)]		Alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	14.89	15.32	14.91	14.62	13.71	15.81
pH (standard units)	5 < x < 9	**6.81**	**6.90**	**6.81**	**6.87**	**6.97**	**6.83**
Conductivity (umhos)	NAp	1.209	1.364	1.300	1.574	1.541	1.936
Turbidity (NTU)	NAp	14.9	0.47	6.9	6.6	10.8	0.55
Natural Attenuation Parameters							
Manganese (mg/L)	NAp	0.04	0.44	0.10	1.15	2.39	ND
Methane (ug/L)	> 500	ND	ND	ND	ND	5	ND
Ethane (ug/L)	> 10	ND	ND	ND	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	368	370	379	413	249	348
Total Organic Carbon (mg/L)	> 20	1.0	1.9	1.1	1.7	2.0	1.3
Nitrate, as N (mg/L)	< 1	1.9	**ND**	1.4	1.3	**ND**	4.2
Sulfate (mg/L)	< 20	143	184	152	165	202	187
Sulfide (mg/L)	>1	ND	ND	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	83	122	111	**183**	**203**	**321**
DO (mg/L) [(2)]	< 0.5	1.22	**0.22**	**0.16**	**0.15**	**0.23**	**0.24**
Oxidation/Reduction Potential (mV) [(2)]	< 50	**43.3**	**-42.5**	**34.3**	72.0	**39.1**	60.1
Ferrous Iron (mg/L) [(2)]	> 1	0.17	0.73	0.12	0.66	0.00	0.00

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Table 4-12
Positive Detections
January 2007 Reduced Groundwater Sampling Event
Pilot Study Report
Fort Riley, Kansas

Sample Point:		KDHE	DCF92-05/01	DCF93-13/01	DCF06-40	DCF02-41	DCF02-44c/01	DCF02-49c/01
Date Sampled:		RSK/MCL	1/23/2007	1/23/2007	1/24/2007	1/23/2007	1/24/2007	1/24/2007
Laboratory Number:			07011338	07011340	07011430	07011339	07011433	07011432
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***4.6***	***0.9***	***1.8***	***84.9***	***9.0***	***7.2***
Tetrachloroethylene	ug/L	5	1.1 U	***6.5***	***69.1***	1.1 U	***56.5***	***20.2***
trans-1,2-Dichloroethylene	ug/L	100	0.5 U	0.5	0.5 U	***1.5***	0.5 U	0.5 U
Trichloroethylene	ug/L	5	***0.6***	***0.9***	0.6 U	***1.8***	***9.1***	***4.4***
Vinyl Chloride	ug/L	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than MCL or KSWQS

Bold, italics - Compound was detected

RSK - Risked Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-12
Positive Detections
January 2007 Reduced Groundwater Sampling Event
Pilot Study Report
Fort Riley, Kansas

		KDHE	B354-99-11c/01
Sample Point:		KDHE	**B354-99-11c/01**
Date Sampled:		RSK/MCL	1/24/2007
Laboratory Number:			06100129
Volatiles	**Units**		
cis-1,2-Dichloroethylene	ug/L	70	***2.3***
Tetrachloroethylene	ug/L	5	***8.7***
trans-1,2-Dichloroethylene	ug/L	100	0.5 U
Trichloroethylene	ug/L	5	***1.3***
Vinyl Chloride	ug/L	2	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than MCL or KSWQS

Bold, italics - Compound was detected

RSK - Risked Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-13
Field Parameters and Geochemical Data
January 2007 Reduced Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions [1]	DCF92-05 1/23/2007	DCF93-13 1/23/2007	DCF06-25 Permanganate	DCF06-40 1/24/2007	DCF02-41 1/23/2007	DCF02-42 Permanganate
Sampling Stabilization Parameters [2]		Terrace	Terrace	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	11.13	10.37	Nap	14.18	13.51	Nap
pH (standard units)	5 < x < 9	**6.67**	**6.47**	Nap	**6.72**	**6.89**	Nap
Conductivity (umhos)	NAp	1.752	1.816	Nap	1.941	1.587	Nap
Turbidity (NTU)	NAp	6.08	3.92	Nap	4.64	8.61	Nap
Natural Attenuation Parameters							
Manganese (mg/L)	NAp	3.04	0.478	Nap	ND	0.592	Nap
Methane (ug/L)	> 500	**6,060**	215	Nap	6.0	ND	Nap
Ethane (ug/L)	> 10	ND	ND	Nap	ND	ND	Nap
Ethene (ug/L)	> 10	ND	ND	Nap	ND	ND	Nap
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	491	434	Nap	437	379	Nap
Total Organic Carbon (mg/L)	> 20	2.8	17.2	Nap	1.8	1.5	Nap
Nitrate, as N (mg/L)	< 1	**ND**	**0.3**	Nap	7.8	**ND**	Nap
Sulfate (mg/L)	< 20	**16.1**	126	Nap	99	123	Nap
Sulfide (mg/L)	>1	0.3	0.8	Nap	ND	ND	Nap
Chloride (mg/L)	86[5]-140[6]	**290**	**279**	Nap	**343**	**257**	Nap
DO (mg/L) [2]	< 0.5	1.50	2.25	Nap	0.93	0.53	Nap
Oxidation/Reduction Potential (mV) [2]	< 50	**-106.8**	**-183.0**	Nap	57.9	**-89.9**	Nap
Ferrous Iron (mg/L) [2]	> 1	**>10**	**1.0**	Nap	0	**6.0**	Nap

NOTES:

(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
µg/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Table 4-13
Field Parameters and Geochemical Data
January 2007 Reduced Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions (1)	DCF02-44c 1/24/2007	DCF02-49c 1/24/2007	B354-99-11c 1/24/2007
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	13.39	14.23	13.17
pH (standard units)	5 < x < 9	**6.72**	**6.84**	**6.71**
Conductivity (umhos)	NAp	1.770	1.550	1.841
Turbidity (NTU)	NAp	11.10	8.19	1.24
Natural Attenuation Parameters				
Manganese (mg/L)	NAp	0.76	4.30	0.015
Methane (ug/L)	> 500	ND	ND	ND
Ethane (ug/L)	> 10	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816(3)-698(4)	402	449	368
Total Organic Carbon (mg/L)	> 20	1.6	2.0	1.9
Nitrate, as N (mg/L)	< 1	2.1	**0.4**	2.3
Sulfate (mg/L)	< 20	121	157	192
Sulfide (mg/L)	>1	ND	ND	ND
Chloride (mg/L)	86(5)-140(6)	**291**	**191**	**290**
DO (mg/L) (2)	< 0.5	**0.46**	**0.25**	**0.31**
Oxidation/Reduction Potential (mV) (2)	< 50	89.8	**-64.7**	**-151.6**
Ferrous Iron (mg/L) (2)	> 1	0	**2.0**	0.30

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

mg/L - milligrams per liter
mV - millivolts
µg/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Bold Shading indicates favorable geochemical conditions.

Table 4-14
Positive Detections
April 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF92-01/01	DCF92-05/01	DCF93-13/01	DCF93-19/01	DCF93-20/01	DCF06-25/01
Date Sampled:		RSK/MCL	4/23/2007	4/20/2007	4/20/2007	4/23/2007	4/20/2007	
Laboratory Number:			07041513	07041490	07041491	07041511	07074192	
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	***4.6***	***3.7***	***6.2***	***13.7***	NA
Tetrachloroethylene	ug/L	5	1.1U	***2.1***	***2.6***	1.1U	***2.5***	NA
Trichloroethylene	ug/L	5	0.6U	***0.9***	***1.9***	0.6U	***4.6***	NA
Vinyl Chloride	ug/L	2	0.8U	0.5 U	0.8U	***2.5***	0.8U	NA

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

Groundwater sampling conducted by EA for LTM

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

U - Compound was not detected

ug/L - micrograms per liter

NA - Not Analyzed

LTM - Long Term Monitoring

Table 4-14
Positive Detections
April 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF96-27/01 4/20/2007 07041448	DCF00-34c/01 4/20/2007 07041444	DCF96-36/01 4/18/2007 07041198	DCF99-37c/01 4/18/2007 07041194	DCF99-38c/01 4/18/2007 07041195	DCF06-40/01 4/20/2007 07041489
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***8***	***1.4***	0.5 U	***10.4***	0.5U	***2.0***
Tetrachloroethylene	ug/L	5	***1.6***	1.1U	1.1U	1.1U	1.1U	***65.8***
Trichloroethylene	ug/L	5	0.6U	0.6U	0.6U	***1***	0.6U	0.6U
Vinyl Chloride	ug/L	2	***1.4***	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

Groundwater sampling conducted by EA for LTM

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

U - Compound was not detected

ug/L - micrograms per liter

NA - Not Analyzed

LTM - Long Term Monitoring

Table 4-14
Positive Detections
April 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF02-41/01 4/23/2007 07041509	DCF02-43/01 4/20/2007 07041488	DCF02-44a/01 4/19/2007 07041396	DCF02-44c/01 4/19/2007 07041395	DCF02-46a/01 4/19/2007 07041398	DCF02-46c/01 4/19/2007 07041397
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***110***	0.5 U	***9.1***	***7.9***	***0.6***	0.5 U
Tetrachloroethylene	ug/L	5	1.1U	1.1U	***56.4***	***56.4***	1.1U	1.1U
Trichloroethylene	ug/L	5	***1.3***	0.6U	***8.4***	***7.1***	0.6U	0.6U
Vinyl Chloride	ug/L	2	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

Groundwater sampling conducted by EA for LTM

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

U - Compound was not detected

ug/L - micrograms per liter

NA - Not Analyzed

LTM - Long Term Monitoring

Table 4-14
Positive Detections
April 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-47a/01	DCF02-47c/01	DCF02-48a/01	DCF02-48c/01	DCF02-49c/01	DCF03-50c/01
Date Sampled:		RSK/MCL	4/19/2007	4/19/2007	4/20/2007	4/20/2007	4/20/2007	4/18/2007
Laboratory Number:			07041394	07041393	07041446	05091899	07041445	07041197
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***5.5***	0.5 U	***7.4***	0.5U	***8.3***	0.5U
Tetrachloroethylene	ug/L	5	***1.5***	1.1U	1.1U	***5.1***	***17.2***	1.1U
Trichloroethylene	ug/L	5	***1.1***	0.6U	***1.7***	0.6U	***6.3***	0.6U
Vinyl Chloride	ug/L	2	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:

KDHE - Kansas Department of Health and Environment
Shaded - Greater than KDHE RSK or MCL
Bold, italics - Compound was detected
Groundwater sampling conducted by EA for LTM
RSK - Risk Based Standard

MCL - Maximum Contaminant Level
U - Compound was not detected
ug/L - micrograms per liter
NA - Not Analyzed
LTM - Long Term Monitoring

Table 4-14
Positive Detections
April 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

	Sample Point:	KDHE	**B354-99-11c/01**
	Date Sampled:	RSK/MCL	4/18/2007
	Laboratory Number:		07041196
Volatiles	**Units**		
cis-1,2-Dichloroethylene	ug/L	70	***2.3***
Tetrachloroethylene	ug/L	5	***8.7***
Trichloroethylene	ug/L	5	***1.6***
Vinyl Chloride	ug/L	2	0.8U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than KDHE RSK or MCL

Bold, italics - Compound was detected

Groundwater sampling conducted by EA for LTM

RSK - Risk Based Standard

MCL - Maximum Contaminant Level

U - Compound was not detected

ug/L - micrograms per liter

NA - Not Analyzed

LTM - Long Term Monitoring

Tab... 4-15
Field Parameters and Geochemical Data
Spring 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions [1]	DCF92-01 04/23/2007	DCF92-05 04/22/2007	DCF93-08 (DRY 04/23/2007	DCF93-13 04/22/2007	DCF93-19 04/23/2007	DCF93-20 04/22/2007	DCF96-25
Sampling Stabilization Parameters [2]								
Temperature (°C)	> 20°C	16.41	14.11	NAp	15.43	16.03	14.26	NAp
pH (standard units)	5 < x < 9	**5.67**	**5.78**	NAp	**5.97**	**6.60**	**6.08**	NAp
Conductivity (umhos)	NAp	1852	2259	NAp	2313	1559	1978	NAp
Turbidity (NTU)	NAp	0.00	0.00	NAp	0.00	9.80	0.0	NAp
Natural Attenuation Parameters								
Methane (ug/L)	> 500	ND	**5,450**	NAp	**2,630**	**1,030**	12	NAp
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	384	439	NAp	452	521	298	NAp
Total Organic Carbon (mg/L)	> 20	1.7	2.2	NAp	**30.1**	5.2	2	NAp
Nitrate, as N (mg/L)	< 1	3.0	**ND**	NAp	**ND**	**ND**	**0.2**	NAp
Nitrite, as N (mg/L)	NAp	ND	ND	NAp	ND	ND	ND	NAp
Sulfate (mg/L)	< 20	136	61	NAp	62	**15.1**	286	NAp
Sulfide (mg/L)	>1	ND	ND	NAp	**5.6**	ND	ND	NAp
Chloride (mg/L)	86[5]-140[6]	**270**	**460**	NAp	**420**	**202**	**300**	NAp
DO (mg/L) [2]	< 0.5	2.39	0.92	NAp	0.68	3.01	2.12	NAp
Oxidation/Reduction Potential (mV) [2]	< 50	409 R	**-74.0**	NAp	**-269.7**	**-81.5**	**13.4**	NAp
Ferrous Iron (mg/L) [2]	> 1	0.01	**1.15**	NAp	**1.21**	**1.65**	0.05	NAp

NOTES:

(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
R - Instrument error

Table 4-15
Field Parameters and Geochemical Data
Spring 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions [1]	DCF96-27 04/20/2007	DCF00-34c 04/20/2007	DCF96-36 04/18/2007	DCF99-37c 04/18/2007	DCF99-38c 04/18/2007	DCF06-40 04/22/2007	DCF02-41 04/23/2007
Sampling Stabilization Parameters [2]								
Temperature (°C)	> 20°C	15.78	No Data	14.28	14.68	14.80	16.77	13.82
pH (standard units)	5 < x < 9	**5.64**	No Data	**6.26**	**6.58**	**6.69**	**6.18**	**6.81**
Conductivity (umhos)	NAp	1307	No Data	1081	1622	1430	1954	1719
Turbidity (NTU)	NAp	190.0	No Data	28.0	0.45	1.5	0.00	5.8
Natural Attenuation Parameters								
Methane (ug/L)	> 500	148	60	6	**1,230**	55	350	ND
Alkalinity, as $CaCO_3$ (mg/L)	816^{3}-698^{4}	376 J	388 J	338	528	208	437	373
Total Organic Carbon (mg/L)	> 20	2.6	1.5	1.9	**39**	3.1	1.7	1.3
Nitrate, as N (mg/L)	< 1	**ND**	**ND**	**ND**	**ND**	**ND**	7.4	**ND**
Nitrite, as N (mg/L)	NAp	ND	ND	ND	ND	ND	ND	ND
Sulfate (mg/L)	< 20	99.6	284	148	**12.5**	194	100	133
Sulfide (mg/L)	>1	ND	ND	0.1	0.1	ND	ND	ND
Chloride (mg/L)	86^{5}-140^{6}	132	**240**	77	**180**	**213**	**300**	**278**
DO (mg/L) [2]	< 0.5	1.88	No Data	0.85	1.19	0.63	1.02	0.59
Oxidation/Reduction Potential (mV) [2]	< 50	**-27.9**	No Data	**-41.2**	**-138.1**	**-137.3**	R	**-49.3**
Ferrous Iron (mg/L) [2]	> 1	0.94	No Data	0.86	**10.40**	**3.25**	0.00	0.00

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
(4) 698 value reflects twice alluvial aquifer (RIA, 2004)
(5) 86 value reflects twice upland terrace aquifer (RIA, 2004)
(6) 140 value reflects twice alluvial aquifer (RIA, 2004)

DO - Dissolved Oxygen
NA - Not Analyzed
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
R - Instrument error

J - Estimated

Tab. 4-15
Field Parameters and Geochemical Data
Spring 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-42 (Bailed) 04/20/2007	DCF02-43 04/22/2007	DCF02-44a 04/19/2007	DCF02-44c 04/19/2007	DCF02-46a 04/19/2007	DCF02-46c 04/19/2007	DCF02-47a 04/19/2007
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	NAp	14.46	15.23	14.78	15.50	15.40	14.64
pH (standard units)	5 < x < 9	NAp	**6.64**	**6.05**	**6.29**	**5.64**	**5.81**	**6.75**
Conductivity (umhos)	NAp	NAp	1079	1933	1838	1153	1101	1247
Turbidity (NTU)	NAp	NAp	0.0	0.00	1.93	0.26	0.4	0.60
Natural Attenuation Parameters								
Methane (ug/L)	> 500	NAp	ND	ND	ND	ND	ND	3
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	NAp	344	428	412	376	350	391
Total Organic Carbon (mg/L)	> 20	NAp	0.9	2.0	1.5	1.4	1.0	2.3
Nitrate, as N (mg/L)	< 1	NAp	1.6	1.9	2.4	**0.4**	1.3	**0.4**
Nitrite, as N (mg/L)	NAp	NAp	ND	ND	ND	ND	ND	ND
Sulfate (mg/L)	< 20	NAp	129	130	122	144	131	174
Sulfide (mg/L)	>1	NAp	ND	ND	ND	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	NAp	79	**280**	**270**	84	85	89
DO (mg/L) (2)	< 0.5	NAp	4.14	0.88	0.73	0.89	3.20	0.86
Oxidation/Reduction Potential (mV) (2)	< 50	NAp	285.2	68.2	264.4	R	R	195.9
Ferrous Iron (mg/L) (2)	> 1	NAp	0.02	0.03	0.00	0.05	0.00	0.03

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
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(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
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DO - Dissolved Oxygen
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NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms
R - Instrument error

Table 4-15
Field Parameters and Geochemical Data
Spring 2007 Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-47c 04/19/2007	DCF02-48a 04/20/2007	DCF02-48c 04/20/2007	DCF02-49c 04/20/2007	DCF03-50c 04/18/2007	B354-99-11c 04/18/2007
Sampling Stabilization Parameters (2)							
Temperature (°C)	> 20°C	14.57	15.08	15.30	14.42	13.96	16.06
pH (standard units)	5 < x < 9	**6.72**	**6.41**	**5.98**	**6.44**	**6.32**	**5.48**
Conductivity (umhos)	NAp	1108	1322	1192	1552	1553	1993
Turbidity (NTU)	NAp	5.7	0.45	0.0	9.5	0.8	7.10
Natural Attenuation Parameters							
Methane (ug/L)	> 500	ND	7	2.0	3.0	6	3.0
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	361	379	371	461	236	382
Total Organic Carbon (mg/L)	> 20	1.0	2.0	1.0	2.6	2.0	2.8
Nitrate, as N (mg/L)	< 1	1.3	**ND**	1.3	**ND**	**ND**	1.7
Nitrite, as N (mg/L)	NAp	ND	ND	ND	ND	ND	ND
Sulfate (mg/L)	< 20	137	182	151	137	231	204
Sulfide (mg/L)	>1	ND	0.5	ND	ND	ND	0.4
Chloride (mg/L)	86[5]-140[6]	78	116	94	**182**	**248**	**300**
DO (mg/L) (2)	< 0.5	1.95	0.56	0.54	0.61	**0.49**	0.71
Oxidation/Reduction Potential (mV) (2)	< 50	198.1	**-105.4**	141.6	**-89.2**	235.0	**-88.5**
Ferrous Iron (mg/L) (2)	> 1	0.04	0.49	0.02	**1.52**	0.02	0.27

NOTES:
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(2) Field Measurement
(3) 816 value reflects twice upland terrace aquifer (RIA, 2004)
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DO - Dissolved Oxygen
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NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units
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mg/L - milligrams per liter
mV - millivolts
ug/L - micrograms per liter
umhos - microohms

Table 4-16
Positive Detections
September and October 2007
Reduced Groundwater Sampling Event
Pilot Study Report
Fort Riley, Kansas

Sample Point:		KDHE	**DCF92-05/01**	**DCF93-13/01**	**DCF06-25/01**	**DCF06-40/01**	**DCF02-41/01**
Date Sampled:		RSK/MCL	9/27/2007	9/27/2007	10/25/2007	9/27/2007	9/27/2007
Laboratory Number:			07092327	07092326	07101857	07092324	07092328
Volatiles	**Units**						
cis-1,2-Dichloroethylene	ug/L	70	***2.6***	***3.4***	0.5 UJ	***2***	***108***
Tetrachloroethylene	ug/L	5	***2.4***	1.1 U	***8 J***	***22.4***	2.2 U
trans-1,2-Dichloroethylene	ug/L	100	0.5 U	0.8 U	0.5 UJ	0.5 U	***1***
Trichloroethylene	ug/L	5	***0.7***	***1.3***	0.6 UJ	***2.5***	1.2 U
Vinyl Chloride	ug/L	2	0.8 U	0.8 U	0.8 UJ	0.8 U	1.6 U

Notes:

KDHE - Kansas Department of Health and Environment

Shaded - Greater than MCL or KSWQS

Bold, italics - Compound was detected

RSK - Risked Based Standard

MCL - Maximum Contaminant Level

µg/L - micrograms per liter

U - Compound was not detected

Table 4-16
Positive Detections
September and October 2007
Reduced Groundwater Sampling Event
Pilot Study Report
Fort Riley, Kansas

Sample Point:		KDHE	**DCF02-42/01**	**DCF02-44c/01**	**DCF02-49c/01**	**B354-99-11c/01**
Date Sampled:		RSK/MCL	10/25/2007	9/28/2007	9/28/2007	9/28/2007
Laboratory Number:			07101856	07092429	07092428	07092430
Volatiles	**Units**					
cis-1,2-Dichloroethylene	ug/L	70	***0.6 J***	***2.7***	***16.5***	***8***
Tetrachloroethylene	ug/L	5	***29.1 J***	***13.2***	***4***	1.1 U
trans-1,2-Dichloroethylene	ug/L	100	0.5 UJ	0.5 U	0.5 U	0.5 U
Trichloroethylene	ug/L	5	***1.2 J***	***2.5***	***5.1***	***1.3***
Vinyl Chloride	ug/L	2	0.8 UJ	0.8 U	0.8 U	0.8 U

Notes:

KDHE - Kansas Department of Health and Environment
Shaded - Greater than MCL or KSWQS
Bold, italics - Compound was detected
RSK - Risked Based Standard

MCL - Maximum Contaminant Level
µg/L - micrograms per liter
U - Compound was not detected

MCL - Maximum Contaminant Level
µg/L - micrograms per liter
U - Compound was not detected

Table 4-17
Field Parameters and Geochemical Data
September and October 2007 Reduced Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions [1]	DCF92-05 9/27/2007	DCF93-13 9/27/2007	DCF06-25 Permanganate	DCF06-40 9/27/2007	DCF02-41 9/27/2007	DCF02-42 Permanganate
Sampling Stabilization Parameters [2]		Terrace	Terrace	Alluvial	Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	14.72	15.34	Nap	17.21	14.73	Nap
pH (standard units)	5 < x < 9	**7.19**	**7.13**	Nap	**7.14**	**7.26**	Nap
Conductivity (umhos)	NAp	2.137	2.181	Nap	1.931	1.600	Nap
Turbidity (NTU)	NAp	1.20	0.95	Nap	1.06	2.37	Nap
Natural Attenuation Parameters							
Manganese (mg/L)	NAp	1.01	2.330	Nap	0.2	0.337	Nap
Methane (ug/L)	> 500	**3,230**	**4000**	Nap	**2,810**	ND	Nap
Ethane (ug/L)	> 10	ND	ND	Nap	ND	ND	Nap
Ethene (ug/L)	> 10	ND	ND	Nap	ND	ND	Nap
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	505	501	Nap	461	375	Nap
Total Organic Carbon (mg/L)	> 20	2.6	12.3	Nap	1.9	1.3	Nap
Nitrate, as N (mg/L)	< 1	**0.7**	**0.7**	Nap	9.7	**ND**	Nap
Sulfate (mg/L)	< 20	136	156	Nap	97	132	Nap
Sulfide (mg/L)	>1	0.1 U	**8.3**	Nap	ND	ND	Nap
Chloride (mg/L)	86[5]-140[6]	**391**	**337**	Nap	**340**	**287**	Nap
DO (mg/L) [2]	< 0.5	1.11	**0.50**	Nap	**0.23**	**0.50**	Nap
Oxidation/Reduction Potential (mV) [2]	< 50	**-287.6**	**-338.7**	Nap	**-303.7**	**-344.3**	Nap
Ferrous Iron (mg/L) [2]	> 1	**>10**	**1.0**	Nap	0	**7.0**	Nap

NOTES:
(1) From USEPA, 1998; favorable reductive chlorination range
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DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

Bold Shading indicates favorable geochemical conditions.

mg/L - milligrams per liter
mV - millivolts
µg/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Table 4-17
Field Parameters and Geochemical Data
September and October 2007 Reduced Groundwater Sampling Event
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Location Sampling Date	Favorable Geochemical Conditions (1)	DCF02-44c 9/28/2007	DCF02-49c 9/28/2007	B354-99-11c 9/28/2007
Sampling Stabilization Parameters (2)		Alluvial	Alluvial	Alluvial
Temperature (°C)	> 20°C	14.34	14.58	16.06
pH (standard units)	5 < x < 9	**7.21**	**7.12**	**7.03**
Conductivity (umhos)	NAp	1.755	1.643	2.190
Turbidity (NTU)	NAp	0.78	1.26	2.00
Natural Attenuation Parameters				
Manganese (mg/L)	NAp	0.06	5.45	0.502
Methane (ug/L)	> 500	ND	55	340
Ethane (ug/L)	> 10	ND	ND	ND
Ethene (ug/L)	> 10	ND	ND	ND
Alkalinity, as $CaCO_3$ (mg/L)	816[3]-698[4]	382	461	621
Total Organic Carbon (mg/L)	> 20	2.1	2.2	**32.9**
Nitrate, as N (mg/L)	< 1	1.1	**ND**	**ND**
Sulfate (mg/L)	< 20	149	133	48
Sulfide (mg/L)	>1	ND	ND	ND
Chloride (mg/L)	86[5]-140[6]	**251**	**183**	**325**
DO (mg/L) (2)	< 0.5	1.20	0.70	**0.43**
Oxidation/Reduction Potential (mV) (2)	< 50	**-240.1**	**-328**	**-314.4**
Ferrous Iron (mg/L) (2)	> 1	0	**2**	0.30

NOTES:
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DO - Dissolved Oxygen
NAp - Not Applicable
ND - Not Detected
NTU - Nephelometric Turbidity Units

mg/L - milligrams per liter
mV - millivolts
µg/L - micrograms per liter
umhos - microohms
°C - degrees Celsius

Bold Shading indicates favorable geochemical conditions.

Table 5-1
Monitoirng Well DCF92-05
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF92-05-01 3/21/2002	DCF92-05/02 7/25/2002	DCF92-05/03 09/30/2002	DCF92-05/01 04/23/2003	DCF92-05/02 07/22/2003	DCF92-05/01 04/20/2004	DCF92-05/02 08/24/2004
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70	**1.1**	0.5 U	0.5 U	**5.8**	0.5 U	**1.8**	0.5 U
Tetrachloroethylene (ug/L)	5	**16**	**14.4**	**18.9**	**24.2**	**17.7**	**11.9**	**9.7**
Trichloroethylene (ug/L)	5	**1**	**1.2**	**1.5**	**2.1**	**1**	**0.9**	0.6 U
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Sample Number / **Sampling Date**	Favorable Geochemical Conditions [1]			**DCF92-05** 9/30/2002	**DCF92-05** 4/23/2003	**DCF92-05** 7/22/2003	**DCF92-05** 4/20/2004	**DCF92-05** 8/24/2004
Sampling Stabilization Parameters [2]								
Temperature (°C)	> 20°C			15.3	13.3	16.1	12.2	15.6
pH (standard units)	5 < x < 9			**6.5**	**6.8**	**6.9**	**6.2**	**6.7**
Conductivity (umhos)	NAp			1,530	1,480	1,480	1540	1470
Turbidity (NTU)	NAp			19	3.7	19.3	29.8	24
Natural Attenuation Parameters								
Methane (ug/L)	> 500							
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]				293	354	370	
Total Organic Carbon (mg/L)	> 20			1.6	1.8	1.8	3.2	
Nitrate, as N (mg/L)	< 1			3.46R	1.2	3.7	1.6	
Sulfate (mg/L)	< 20			94	80	94	59.8	
Sulfide (mg/L)	>1				0.1U	0.1U	0.1 U	
Chloride (mg/L)	>2X Backgnd [3]				**210**	**200**	**205**	
Dissolved Oxygen (mg/L) [2]	< 0.5			4.86	7.80	5.10	3.17	12.56
Oxidation/Reduction Potential (mV) [2]	< 50			125	141	99	117	52
Ferrous Iron (mg/L) [2]	> 1			0.68	0.02	0.02	0.05	

[1] From USEPA, 1998; These geochemical conditions represent a
[2] Field Measurement
[3] Background is 408 mg/L alkalinity and 43 mg/L chloride.

Bold = Greater than KDHE RSL/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment
U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risk Based Standards
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-1
Monitoirng Well DCF92-05
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number Sampling Date	KDHE RSK/MCL	DCF92-05/01 4/15/2005	DCF92-05/01 10/4/2005	DCF92-05/01 3/31/2006				DCF92-05/01 10/2/2006
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70	**0.7**	0.5 U	0.5 U				0.5 U
Tetrachloroethylene (ug/L)	5	**7.4**	**8.4**	**5.9**				**5.7**
Trichloroethylene (ug/L)	5	0.5 U	0.5 U	0.5 U				0.6 U
Vinyl Chloride (ug/L)	2	0.5 U	0.5 U	0.5 U				0.8 U
Sample Number **Sampling Date**	Favorable Geochemical Conditions [1]	**DCF92-05** 4/15/2005	**DCF92-05** 10/4/2005	**DCF92-05** 03/31/2006	**DCF92-05** 7/24/2006	**DCF92-05** 8/23/2006	**DCF92-05** 9/5/2006	**DCF92-05** 10/2/2006
Sampling Stabilization Parameters [2]								
Temperature (°C)	> 20°C	11.9	16.8	11.28	12.99	14.45	14.19	15.61
pH (standard units)	5 < x < 9	**7.4**	**7.0**	**6.54**	**5.73**	**6.81**	**6.33**	**6.89**
Conductivity (umhos)	NAp	1290	990	2053	1397	1321	1720	1772
Turbidity (NTU)	NAp	14	20.8	3.49				1.11
Natural Attenuation Parameters								
Methane (ug/L)	> 500	2 U		ND				41
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]	334		323				403
Total Organic Carbon (mg/L)	> 20	2.3		2.1				2.4
Nitrate, as N (mg/L)	< 1	2.6		2.9				1.4
Sulfate (mg/L)	< 20	81		85.2				66
Sulfide (mg/L)	>1	0.1 U		ND				ND
Chloride (mg/L)	>2X Backgnd [3]	**339**		**518**				**311**
Dissolved Oxygen (mg/L) [2]	< 0.5	7.58	4.32	7.15	3.7	1.97	1.73	3.48
Oxidation/Reduction Potential (mV) [2]	< 50	134	136.80	126.1	**-41**	**-31.9**	**-136.3**	**-66.1**
Ferrous Iron (mg/L) [2]	> 1	0.00		0.20	0.6	0.6	0.1	0.18

[1] From USEPA, 1998; These geochemical conditions represent a
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KDHE - Kansas Department of Health and Environment
U - Not detected
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ug/L - micrograms per liter
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RSK - Risk Based Standards
umhos - microohms
NTU - nephelometric turbidity
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Ta 5-1
Monitoirng Well DCF92-05
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL			DCF92-05/01 1/23/2007	DCF92-05/01 4/20/2007			DCF92-05/01 9/27/2007
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70			**4.6**	**4.6**			**2.6**
Tetrachloroethylene (ug/L)	5			1.1 U	**2.1**			**2.4**
Trichloroethylene (ug/L)	5			**0.6**	**0.9**			**0.7**
Vinyl Chloride (ug/L)	2			0.8 U	0.5 U			0.8 U
Sample Number / Sampling Date	Favorable Geochemical Conditions (1)	**DCF92-05** 11/6/2006	**DCF92-05** 12/6/2006	**DCF92-05** 1/23/2007	**DCF92-05** 04/22/2007	**DCF92-05** 7/18/2007	**DCF92-05** 8/23/2007	**DCF92-05** 9/27/2007
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	14.1	13.9	11.13	14.11	14.37	14.49	14.72
pH (standard units)	5 < x < 9	**6.72**	**6.9**	**6.67**	**5.78**	**6.69**	**6.81**	**7.19**
Conductivity (umhos)	NAp	1817	1767	1752	2259	2123	1321	2
Turbidity (NTU)	NAp			6.08	0.00			1.2
Natural Attenuation Parameters								
Methane (ug/L)	> 500			3.04	**5,450**			**3,230**
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)			491	439			505
Total Organic Carbon (mg/L)	> 20			2.8	2.2			2.6
Nitrate, as N (mg/L)	< 1			**ND**	**ND**			**0.7**
Sulfate (mg/L)	< 20			**16.1**	61			136
Sulfide (mg/L)	>1			0.3	ND			0.1 U
Chloride (mg/L)	>2X Backgnd (3)			**290**	**460**			**391**
Dissolved Oxygen (mg/L) (2)	< 0.5	4.5	0.58	1.50	0.92	0.56	1.97	1.11
Oxidation/Reduction Potential (mV) (2)	< 50	**-194.7**	**-86.2**	**-106.8**	**-74.0**	**-130.9**	**-31.9**	**-287.6**
Ferrous Iron (mg/L) (2)	> 1	**8**	**10**	**>10**	**1.15**		0.6	**>10**

(1) From USEPA, 1998; These geochemical conditions represent a
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.

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Bold = Favorable Geochemical Conditions
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NTU - nephelometric turbidity
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Tab. 5-2
Monitoirng Well DCF06-40
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF01-40-01 3/21/2002	DCF01-40/02 7/23/2002	DCF01-40/03 10/01/2002	DCF01-40/01 04/24/2003	DCF01-40/02 07/22/2003	DCF01-40/01 04/19/2004	DCF01-40/02 08/24/2004
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethylene (ug/L)	5	**169**	**121**	**165**	**74.8**	**113**	**47.3**	**89.6**
Trichloroethylene (ug/L)	5	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

Sample Number / Sampling Date	Favorable Geochemical Conditions (1)			DCF01-40 10/1/2002	DCF01-40 4/24/2003	DCF01-40 7/22/2003	DCF01-40 4/19/2004	DCF01-40 8/24/2004
Sampling Stabilization Parameters (2)								
Temperature (^{o}C)	> 20^{o}C			18.6	14.8	22.5	18.3	18.0
pH (standard units)	5 < x < 9			**6.8**	**7.3**	**6.8**	**6.9**	**6.9**
Conductivity (umhos)	NAp			1,710	2,200	1,960	2,340	2,140
Turbidity (NTU)	NAp			18.4	4.0	0.0	1.0	0.9
Natural Attenuation Parameters								
Methane (ug/L)	> 500			2U	2U	2U	2 U	
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)			423	395	386	337	
Total Organic Carbon (mg/L)	> 20			1.2	1.5	1.5	1.5	
Nitrate, as N (mg/L)	< 1			8.5	18.8	9.1	12.6	
Sulfate (mg/L)	< 20			120	150	110	110	
Sulfide (mg/L)	>1				0.1U	0.1U	0.1 U	
Chloride (mg/L)	>2X Backgnd (3)				**380**	**290**	**352**	
Dissolved Oxygen (mg/L) (2)	< 0.5			2.93	4.80	2.95	8.60	7.43
Oxidation/Reduction Potential (mV) (2)	< 50			88	201	104	106	132
Ferrous Iron (mg/L) (2)	> 1			0.75	0.28	0.36	0.00	

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment
U - Not detected
ND - Not detected
ug/L - micrograms per liter
^{o}C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risk Based Standard
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-2
Monitoirng Well DCF06-40
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF01-40/01 4/15/2005	DCF06-40/01 10/4/2005	DCF06-40/01 3/29/2006				DCF06-40/01 10/3/2006	
Contaminant of Concern Results									
cis-1,2-Dichloroethylene (ug/L)	70	0.5 U	0.5 U	0.5 U				**1.2**	
Tetrachloroethylene (ug/L)	5	**56.6**	**80.2**	**78.1**				**61.2**	
Trichloroethylene (ug/L)	5	0.5 U	0.5 U	0.5 U				0.6 U	
Vinyl Chloride (ug/L)	2	0.5 U	0.5 U	0.5 U				0.8 U	

Sample Number / Sampling Date	Favorable Geochemical Conditions [1]	DCF06-40 4/15/2005	DCF01-40 10/4/2005	DCF06-40 03/29/2006	DCF06-40 7/24/2006	DCF06-40 8/23/2006	DCF06-40 9/5/2006	DCF06-40 10/3/2006	DCF06-40 11/6/2006
Sampling Stabilization Parameters [2]									
Temperature (°C)	> 20°C	16.6	19.7	15.47	17.27	20.15	17.61	17.94	15.94
pH (standard units)	5 < x < 9	**7.6**	**7.0**	**6.74**	**6.31**	**6.86**	**6.51**	**6.78**	**6.74**
Conductivity (umhos)	NAp	1,530	1,410	3,473	1,633	1,780	1,954	2,067	1,999
Turbidity (NTU)	NAp	1.0	7.9	1.84				0.38	
Natural Attenuation Parameters									
Methane (ug/L)	> 500	2 U		ND				ND	
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]	381		394				413	
Total Organic Carbon (mg/L)	> 20	1.6		1.5				1.6	
Nitrate, as N (mg/L)	< 1	18.3		13.9				7.4	
Sulfate (mg/L)	< 20	127		112				103	
Sulfide (mg/L)	>1	0.1 U		ND				ND	
Chloride (mg/L)	>2X Backgnd [3]	**398 J**		**332**				**350**	
Dissolved Oxygen (mg/L) [2]	< 0.5	5.72	4.36	4.31	2.08	1.1	1.49	1.26	1.24
Oxidation/Reduction Potential (mV) [2]	< 50	146	81.20	120.7	**40.1**	**41.8**	**-91.1**	57.1	**-197.7**
Ferrous Iron (mg/L) [2]	> 1	0.03		0.41	0.1	0	0	0.56	0

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - P' 'ased Standard

umhos - microohms
NTU - nephelometric turbi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-2
Monitoirng Well DCF06-40
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number Sampling Date	KDHE RSK/MCL		DCF06-40/11 1/24/2007	DCF06-40/01 4/20/2007				DCF06-40/01 9/27/2007
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70		**1.8**	**2.0**				1.9
Tetrachloroethylene (ug/L)	5		**69.1**	**65.8**				**22.4**
Trichloroethylene (ug/L)	5		0.6 U	0.6U				2.4
Vinyl Chloride (ug/L)	2		0.8 U	0.8U				0.8 U
Sample Number Sampling Date	Favorable Geochemical Conditions (1)	DCF06-40 12/6/2006	DCF06-40 1/24/2007	DCF06-40 04/22/2007	DCF06-40 6/19/2007	DCF06-40 7/18/2007	DCF06-40 8/23/2007	DCF06-40 9/27/2007
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	14.25	14.18	16.77	17.63	18.67	20.15	17.21
pH (standard units)	5 < x < 9	**6.99**	**6.72**	**6.18**	**6.58**	**6.65**	**6.86**	**7.14**
Conductivity (umhos)	NAp	1,903	1,941	1,954	1,678	1,903	1,780	1,931
Turbidity (NTU)	NAp		4.64	0.00				1.06
Natural Attenuation Parameters								
Methane (ug/L)	> 500		ND	350				**2,810**
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)		427	437				375
Total Organic Carbon (mg/L)	> 20		1.7	1.7				1.9
Nitrate, as N (mg/L)	< 1		7.8	7.4				9.7
Sulfate (mg/L)	< 20		97	100				97
Sulfide (mg/L)	>1		ND	ND				ND
Chloride (mg/L)	>2X Backgnd (3)		**340**	**300**				**340**
Dissolved Oxygen (mg/L) (2)	< 0.5	1.55	0.93	1.02	**0.48**	**0.24**	1.1	**0.23**
Oxidation/Reduction Potential (mV) (2)	< 50	**-19.9**	57.9	403.2	75.6	**-0.8**	**41.8**	**-344.3**
Ferrous Iron (mg/L) (2)	> 1	0.6	0	0.00			0	0

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment
U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risk Based Standard
umhos - microohms
NTU - nephelometric turbi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-3
Monitoirng Well DCF93-13
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF93-13-01 3/19/2002	DCF93-13/02 7/24/2002	DCF93-13/01 04/23/2003	DCF93-13/02 07/22/2003	DCF93-13/01 04/20/2004	DCF93-13/02 08/23/2004	DCF93-13/01 4/15/2005
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70	15.9	58.4	8	19.7	4	24.1	2
Tetrachloroethylene (ug/L)	5	**61.5**	**72.8**	**44.5**	**63.2**	**36.3**	**33.2**	**26.7**
Trichloroethylene (ug/L)	5	**56.5**	**256**	**18.9**	**76.1**	**13.4**	**66.7**	**5.8**
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.5 U

Sample Number / Sampling Date	Favorable Geochemical Conditions (1)		DCF93-13 10/8/2002		DCF93-13 7/22/2003	DCF93-13 4/20/2004	DCF93-13 8/23/2004	DCF93-13 4/15/2005
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C		14.9		15.9	14.5	16.3	14.4
pH (standard units)	5 < x < 9		**6.9**		**6.9**	**7.0**	**7.1**	**7.5**
Conductivity (umhos)	NAp		1,620		1,700	1,680	1,970	1,460
Turbidity (NTU)	NAp		7.9		98	2.94	7.0	9.7
Natural Attenuation Parameters								
Methane (ug/L)	> 500							2 U
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)		297		361	330		327
Total Organic Carbon (mg/L)	> 20		1.7		2.2	2.5		1.9
Nitrate, as N (mg/L)	< 1		1.5		2.8	1.7		2.7
Sulfate (mg/L)	< 20		100		110	70.9		96
Sulfide (mg/L)	>1		0.1U		0.1U	0.1 U		0.1 U
Chloride (mg/L)	>2X Backgnd (3)		**240**		**240**	**239**		**408 J**
Dissolved Oxygen (mg/L) (2)	< 0.5		5.80		4.24	2.86	5.50	5.25
Oxidation/Reduction Potential (mV) (2)	< 50		77		98	51	**24**	75
Ferrous Iron (mg/L) (2)	> 1		0.05		0.04	0.00		0.02

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.
KDHE - Kansas Department of Health and Environment
Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
RSK - Risk Based Standards
U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-3
Monitoirng Well DCF93-13
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF93-13/01 10/4/2005	DCF93-13/01 3/31/2006				DCF93-13/01 10/3/2006		
Contaminant of Concern Results									
cis-1,2-Dichloroethylene (ug/L)	70	9.9	2				0.5 U		
Tetrachloroethylene (ug/L)	5	**26.5**	**28.7**				**9.6**		
Trichloroethylene (ug/L)	5	**20.6**	**6.7**				1.4		
Vinyl Chloride (ug/L)	2	0.5 U	0.5 U				0.8 U		

Sample Number / Sampling Date	Favorable Geochemical Conditions [1]	DCF93-13 10/4/2005	DCF93-13 03/31/2006	DCF93-13 7/24/2006	DCF93-13 8/23/2006	DCF93-13 9/5/2006	DCF93-13 10/3/2006	DCF93-13 11/6/2006	DCF93-13 12/6/2006
Sampling Stabilization Parameters [2]									
Temperature (°C)	> 20°C	16.7	15.43	17.73	14.9	14.83	17.10	14.21	13.82
pH (standard units)	5 < x < 9	**7.1**	**6.82**	**6.17**	**7.04**	**6.43**	**6.83**	**6.75**	**7.01**
Conductivity (umhos)	NAp	1,160	1,816	1,554	1,206	1,634	1,850	1,834	1,711
Turbidity (NTU)	NAp	3.9	2.67				2.15		
Natural Attenuation Parameters									
Methane (ug/L)	> 500		ND				3		
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]		328				382		
Total Organic Carbon (mg/L)	> 20		1.9				9.1		
Nitrate, as N (mg/L)	< 1		2.7				**0.5**		
Sulfate (mg/L)	< 20		95				97.0		
Sulfide (mg/L)	>1		ND				**1.4**		
Chloride (mg/L)	>2X Backgnd [3]		**482**				**280**		
Dissolved Oxygen (mg/L) [2]	< 0.5	4.20	5.19	3.3	**0.4**	**0.53**	2.57	3.32	1.54
Oxidation/Reduction Potential (mV) [2]	< 50	102.5	89.2	**-66.5**	**-113.5**	**-261.3**	**-132.1**	**-242.2**	**-40.2**
Ferrous Iron (mg/L) [2]	> 1		0.00	**3**	**7**	**2**	0.03	0.1	0.6

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 408 mg/L alkalinity and 43 mg/L chloride.
KDHE - Kansas Department of Health and Environment
Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
RSK - Risk Based Standards
U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Ma~~mum contaminant level
umhos - microohms
NTU - nephelometric turbi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-3
Monitoirng Well DCF93-13
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF93-13/01 1/23/2007	DCF93-13/01 4/20/2007				DCF93-13/01 9/27/2007
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	**0.9**	**3.7**				**3.4**
Tetrachloroethylene (ug/L)	5	**6.5**	**2.6**				1.1 U
Trichloroethylene (ug/L)	5	**0.9**	**1.9**				**1.3**
Vinyl Chloride (ug/L)	2	0.8 U	0.8U				0.8 U
Sample Number / Sampling Date	**Favorable Geochemical Conditions [1]**	**DCF93-13 1/23/2007**	**DCF93-13 04/22/2007**	**DCF93-13 6/19/2007**	**DCF93-13 7/18/2007**	**DCF93-13 8/23/2007**	**DCF93-13 9/27/2007**
Sampling Stabilization Parameters [2]							
Temperature ($^{\circ}$C)	> 20°C	10.37	15.43	15.6	16	14.9	15.34
pH (standard units)	5 < x < 9	**6.47**	**5.97**	**6.58**	**6.65**	**7.04**	**7.13**
Conductivity (umhos)	NAp	1,816	2,313	2,091	2,419	1,206	2,137
Turbidity (NTU)	NAp	3.92	0.00				0.95
Natural Attenuation Parameters							
Methane (ug/L)	> 500	0.478	**2,630**				**4,000**
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]	434	452				501
Total Organic Carbon (mg/L)	> 20	17.2	**30.1**				12.3
Nitrate, as N (mg/L)	< 1	**0.3**	**ND**				**0.7**
Sulfate (mg/L)	< 20	126	62				156
Sulfide (mg/L)	>1	0.8	**5.6**				**8.3**
Chloride (mg/L)	>2X Backgnd [3]	**279**	**420**				**337**
Dissolved Oxygen (mg/L) [2]	< 0.5	2.25	**0.68**	**0.026**	**0.46**	**0.4**	**0.5**
Oxidation/Reduction Potential (mV) [2]	< 50	**-183.0**	**-269.7**	**-73.9**	**-226.6**	**-113.4**	**-338.7**
Ferrous Iron (mg/L) [2]	> 1	**1.0**	**1.21**			0.6	**1**

[1] From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
[2] Field Measurement
[3] Background is 408 mg/L alkalinity and 43 mg/L chloride.
KDHE - Kansas Department of Health and Environment
Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
RSK - Risk Based Standards
U - Not detected
ND - Not detected
ug/L - micrograms per liter
$^{\circ}$C - degrees Celsius
MCL - Maximum contaminant level
umhos - microohms
NTU - nephelometric turbi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-4
Monitoirng Well DCF02-41
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF02-41/03 10/08/2002	DCF02-41/01 04/24/2003	DCF02-41/22 07/23/2003	DCF02-41/01 04/20/2004	DCF02-41/02 08/24/2004	DCF02-41/11 4/13/2005	DCF02-41/01 10/3/2005
Contaminant of Concern Results								
cis-1,2-Dichloroethylene (ug/L)	70	**39.6**	**51.3**	**57.6**	**51.5 J**	**77.9**	**97.8**	**74.3**
Tetrachloroethylene (ug/L)	5	**10.9**	**2.4**	1.1 U	2.2 UJ	2.2 U	0.5 U	0.5 U
Trichloroethylene (ug/L)	5	**39**	**26.8**	**22.1**	**17.8**	**11 J**	**6.6**	**5.3**
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	2 UJ	2 U	0.5 U	0.5 U

Sample Number / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-41 10/8/2002	DCF02-41 4/24/2003	DCF02-41 7/23/2003	DCF02-41 4/20/2004	DCF02-41 8/24/2004	DCF02-41 4/13/2005	DCF02-41 10/3/2005
Sampling Stabilization Parameters (2)								
Temperature (°C)	> 20°C	14.4	13.7	14.3	14.1	15.2	13.7	15.8
pH (standard units)	5 < x < 9	**6.7**	**7.0**	**7.0**	**6.7**	**6.7**	**7.0**	**6.9**
Conductivity (umhos)	NAp	1,290	1,550	1,520	1,680	1,750	1,160	1,020
Turbidity (NTU)	NAp	10.5	9.5	0.0	13.6	5.6	11	5.5
Natural Attenuation Parameters								
Methane (ug/L)	> 500	2U	2U	2U	2 U		2 U	
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)	378	400	381	386		376	
Total Organic Carbon (mg/L)	> 20	1.6	0.9	1.0	1.3		1.4	
Nitrate, as N (mg/L)	< 1	**0.1U**	**0.1U**	**0.1U**	**0.1 U**		**0.1 U**	
Sulfate (mg/L)	< 20	120	130	140	130		126	
Sulfide (mg/L)	>1		0.1U	0.1U	0.1 U		0.1 U	
Chloride (mg/L)	>2X Backgnd (3)		**190**	**180**	197		**257**	
Dissolved Oxygen (mg/L) (2)	< 0.5	**0.48**	**0.48**	0.98	**0.35**	1.42	0.51	**0.31**
Oxidation/Reduction Potential (mV) (2)	< 50	**-67**	**-114**	**-132**	**-112**	**-89**	**-167**	**-94.60**
Ferrous Iron (mg/L) (2)	> 1	**2.29**	**221**	**2.29**	**3.29**		**1.69**	

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risked Based Standards
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-4
Monitoirng Well DCF02-41
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number Sampling Date	KDHE RSK/MCL	DCF02-41/11 3/30/2006				DCF02-41/11 10/4/2006			DCF02-41 1/23/2007
Contaminant of Concern Results									
cis-1,2-Dichloroethylene (ug/L)	70	**83.3**				**84.3**			**84.9**
Tetrachloroethylene (ug/L)	5	0.5 U				1.1 U			1.1 U
Trichloroethylene (ug/L)	5	**3.5**				**2**			**1.8**
Vinyl Chloride (ug/L)	2	0.5 U				0.8 U			0.8 U
Sample Number Sampling Date	Favorable Geochemical Conditions (1)	**DCF02-41** 03/30/2006	**DCF02-41** 7/24/2006	**DCF02-41** 8/23/2006	**DCF02-41** 9/5/2006	**DCF02-41** 10/4/2006	**DCF02-41** 11/6/2006	**DCF02-41** 12/6/2006	**DCF02-41** 1/23/2007
Sampling Stabilization Parameters (2)									
Temperature (°C)	> 20°C	14.49	13.84	14.84	14.75	14.75	14.34	13.5	13.51
pH (standard units)	5 < x < 9	**6.90**	**6.67**	**7.04**	**6.9**	**6.84**	**6.92**	**7.18**	**6.89**
Conductivity (umhos)	NAp	1,478	1,360	1,319	1,597	1,700	1,621	1,540	1,587
Turbidity (NTU)	NAp	12.8				3.1			8.61
Natural Attenuation Parameters									
Methane (ug/L)	> 500	ND				ND			0.592
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)	3947				373			379
Total Organic Carbon (mg/L)	> 20	1.5				1.3			1.5
Nitrate, as N (mg/L)	< 1	**ND**				**ND**			**ND**
Sulfate (mg/L)	< 20	137				123			123
Sulfide (mg/L)	>1	ND				ND			ND
Chloride (mg/L)	>2X Backgnd (3)	**239**				**255**			**257**
Dissolved Oxygen (mg/L) (2)	< 0.5	**0.26**	1.37	1.08	0.67	**0.3**	**0.3**	2.79	0.53
Oxidation/Reduction Potential (mV) (2)	< 50	**18.4**	**-59.1**	**-70.8**	**-91.9**	**-71.4**	**-212.4**	**-97.3**	**-89.9**
Ferrous Iron (mg/L) (2)	> 1	**2.90**	**7**	**5**	**5**	**3.11**	**4.5**	**4**	**6.0**

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - R ' Based Standards

umhos - microohms
NTU - nephelometric turbidi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-4
Monitoirng Well DCF02-41
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF02-41/01 4/23/2007			DCF02-41/01 9/27/2007
Contaminant of Concern Results					
cis-1,2-Dichloroethylene (ug/L)	70	**110**			**108**
Tetrachloroethylene (ug/L)	5	1.1U			2.2 U
Trichloroethylene (ug/L)	5	1.3			1.2 U
Vinyl Chloride (ug/L)	2	0.8U			1.6 U

Sample Number / Sampling Date	Favorable Geochemical Conditions [1]	DCF02-41 04/23/2007	DCF02-41 7/18/2007	DCF02-41 8/23/2007	DCF02-41 9/27/2007
Sampling Stabilization Parameters [2]					
Temperature (°C)	> 20°C	13.82	14.82	14.84	14.73
pH (standard units)	5 < x < 9	**6.81**	**6.88**	**7.04**	**7.26**
Conductivity (umhos)	NAp	1,719	1,611	1,319	1,600
Turbidity (NTU)	NAp	5.8			2.37
Natural Attenuation Parameters					
Methane (ug/L)	> 500	ND			ND
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]	373			375
Total Organic Carbon (mg/L)	> 20	1.3			1.3
Nitrate, as N (mg/L)	< 1	**ND**			**ND**
Sulfate (mg/L)	< 20	133			132
Sulfide (mg/L)	>1	ND			ND
Chloride (mg/L)	>2X Backgnd [3]	**278**			**287**
Dissolved Oxygen (mg/L) [2]	< 0.5	0.59	**0.29**	1.08	**0.5**
Oxidation/Reduction Potential (mV) [2]	< 50	**-49.3**	**-128.9**	**-70.8**	**-344.3**
Ferrous Iron (mg/L) [2]	> 1	0.00		**5**	**7**

(1) From USEPA, 1998; These geochemical conditions represent a range that is favorable for reductive dechlorination.
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment
U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risked Based Standards
umhos - microohms
NTU - nephelometric turbidi
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-5
Monitoirng Well DCF02-49c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF02-49c/03 10/10/2002	DCF02-49c/01 05/02/2003	DCF02-49c/02 07/25/2003	DCF02-49c/01 04/14/2004	DCF02-49c/02 08/18/2004	DCF02-49c/01 4/13/2005
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	**3.2**	**3.8**	**3.7**	**4.3**	**6.9**	**6.8**
Tetrachloroethylene (ug/L)	5	**5.4**	**10.5**	**13.3**	**22.7**	**16.8**	**24.5**
Trichloroethylene (ug/L)	5	**1.8**	**2.5**	**2.9**	**3.7**	**4.6**	**4.6**
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.5 U
Sample Number / Sampling Date	Favorable Geochemical Conditions (1)	DCF02-49c 10/10/2002	DCF02-49c 5/2/2003	DCF02-49c 7/25/2003	DCF02-49c 4/14/2004	DCF02-49c 8/18/2004	DCF02-49c 4/13/2005
Sampling Stabilization Parameters (2)							
Temperature (°C)	> 20°C	14.3	14.3	15.6	14.4	16.6	13.6
pH (standard units)	5 < x < 9	**6.9**	**6.8**	**6.9**	**7.0**	**7.0**	**7.0**
Conductivity (umhos)	NAp	1,370	1,800	1,710	1,770	1,800	1,260
Turbidity (NTU)	NAp	16.9	8.7	29.4	4.1	17.1	23
Natural Attenuation Parameters							
Methane (ug/L)	> 500	2U	4	8	4 U		2 U
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)	382	392	328	432		426
Total Organic Carbon (mg/L)	> 20	1.5	1.7	1.6	1.9		1.9
Nitrate, as N (mg/L)	< 1	**0.4**	**0.7**	1.0	1.7		1.7
Sulfate (mg/L)	< 20	140	160	160	149		160
Sulfide (mg/L)	>1		0.1U	0.1U	0.1 U		0.1 U
Chloride (mg/L)	>2X Backgnd (3)		**200**	**200**	196		**207**
Dissolved Oxygen (mg/L) (2)	< 0.5	0.55	0.71	**0.29**	1.55	1.30	**0.38**
Oxidation/Reduction Potential (mV) (2)	< 50	138	**41**	109	77	**-56**	113
Ferrous Iron (mg/L) (2)	> 1	0.07	0.04	0.1	0.10		0.07

(1) From USEPA, 1998; These geochemical conditions represent a
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risk Based Standards

umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-5
Monitoirng Well DCF02-49c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF02-49c/01 9/30/2005	DCF02-49c/01 3/29/2006	DCF02-49c/01 10/4/2006	DCF02-49c/01 1/24/2007	DCF02-49c/01 4/20/2007	DCF02-49c/01 9/28/2007
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	6.1	6.5	5.8	7.2	8.3	16.5
Tetrachloroethylene (ug/L)	5	**26.3**	**30.4**	**24.3**	**20.2**	**17.2**	4
Trichloroethylene (ug/L)	5	4.3	4.9	4	4.4	**6.3**	**5.1**
Vinyl Chloride (ug/L)	2	0.5 U	0.5 U	0.8 U	0.8 U	0.8U	0.8 U

Sample Number / Sampling Date	Favorable Geochemical Conditions [1]	DCF02-49c 9/30/2005	DCF02-49c 03/29/2006	DCF02-49c 10/4/2006	DCF02-49c 1/24/2007	DCF02-49c 04/20/2007	DCF02-49c 9/28/2007
Sampling Stabilization Parameters [2]							
Temperature (°C)	> 20°C	14.4	14.69	14.62	14.23	14.42	14.58
pH (standard units)	5 < x < 9	**7.1**	**7.17**	**6.87**	**6.84**	**6.44**	**7.12**
Conductivity (umhos)	NAp	1,070	2,779	1,574	1,550	1,552	1,623
Turbidity (NTU)	NAp	14.5	27.6	6.6	8.19	9.5	1.3
Natural Attenuation Parameters							
Methane (ug/L)	> 500		ND	ND	4.30	3.0	55
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]		420	413	449	461	461
Total Organic Carbon (mg/L)	> 20		1.7	1.7	2.0	2.6	2.2
Nitrate, as N (mg/L)	< 1		1.5	1.3	**0.4**	**ND**	**ND**
Sulfate (mg/L)	< 20		170	165	157	137	133
Sulfide (mg/L)	>1		ND	ND	ND	ND	ND
Chloride (mg/L)	>2X Backgnd [3]		**186**	**183**	**191**	**182**	**183**
Dissolved Oxygen (mg/L) [2]	< 0.5	**0.26**	1.50	**0.15**	**0.25**	0.61	0.70
Oxidation/Reduction Potential (mV) [2]	< 50	60.40	**47.7**	72.0	**-64.7**	**-89.2**	**-328**
Ferrous Iron (mg/L) [2]	> 1		0.52	0.66	**2.0**	**1.52**	**2.0**

(1) From USEPA, 1998; These geochemical conditions represent a
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

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U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
RSK - Risk Based Standards
umhos - microohms
NTU - nephelometric turbic
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-6
Monitoirng Well DCF99-37c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	DCF99-37c-11 3/25/2002	DCF99-37c/02 7/25/2002	DCF99-37c/33 10/08/2002	DCF99-37c/01 05/01/2003	DCF99-37c/02 07/25/2003	DCF99-37c/01 04/13/2004
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	1.9	2.3	6.4	9.9	2.2	2.2
Tetrachloroethylene (ug/L)	5	**8.6**	**7.3**	**6.8**	3.3	**8.3**	**6.9**
Trichloroethylene (ug/L)	5	1.7	1.8	2.8	1	2.5	1.9
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

Sample Number / Sampling Date	Favorable Geochemical Conditions [1]	DCF99-37c 10/8/2002			DCF99-37c 5/1/2003	DCF99-37c 7/25/2003	DCF99-37c 4/13/2004
Sampling Stabilization Parameters [2]							
Temperature (°C)	> 20°C	14.6			14.6	15.5	14.6
pH (standard units)	5 < x < 9	**6.9**			**6.7**	**6.8**	**6.8**
Conductivity (umhos)	NAp	1,420			1,700	1,490	1500
Turbidity (NTU)	NAp	0.0			0.0	3.9	0.7
Natural Attenuation Parameters							
Methane (ug/L)	> 500	2UJ			2	2U	2 U
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]	344			341	313	343
Total Organic Carbon (mg/L)	> 20	2.0			1.4	1.3	1.4
Nitrate, as N (mg/L)	< 1	**0.1U**			**0.7**	2.6	2.0
Sulfate (mg/L)	< 20	160			170	160	146
Sulfide (mg/L)	>1				0.1U	0.1U	0.1 U
Chloride (mg/L)	>2X Backgnd [3]				**180**	**190**	169
Dissolved Oxygen (mg/L) [2]	< 0.5	0.68			0.63	1.00	**0.5**
Oxidation/Reduction Potential (mV) [2]	< 50	79			**6**	**-21**	128
Ferrous Iron (mg/L) [2]	> 1	0.39			0.07	0.00	0.00

[1] From USEPA, 1998; These geochemical conditions represent a
[2] Field Measurement
[3] Background is 315 mg/L alkalinity and 73 mg/L chloride.

RSK - Risked Based Standards
Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
J - Estimated
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-6
Monitoirng Well DCF99-37c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number Sampling Date	KDHE RSK/MCL	DCF99-37c/02 08/17/2004	DCF99-37c/11 4/12/2005	DCF99-37c/01 9/29/2005	DCF99-37c/01 3/28/2006	DCF99-37c/11 10/3/2006	DCF99-37c/01 4/18/2007
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	**2.5**	**10.1**	**0.6**	**8.4**	**0.7**	**10.1**
Tetrachloroethylene (ug/L)	5	**6.7**	0.5 U	**10**	**3.7**	**8.1**	1.1U
Trichloroethylene (ug/L)	5	**1.8**	**0.8**	**1**	**0.7**	**0.9**	**1**
Vinyl Chloride (ug/L)	2	0.8 U	0.5 U	0.5 U	0.5 U	0.8 U	0.8U
Sample Number **Sampling Date**	Favorable Geochemical Conditions [1]	**DCF99-37c** 8/17/2004	**DCF99-37c** 4/12/2005	**DCF99-37c** 9/29/2005	**DCF99-37c** 03/28/2006	**DCF99-37c** 10/3/2006	**DCF99-37c** 04/18/2007
Sampling Stabilization Parameters [2]							
Temperature (°C)	> 20°C	17.4	14.3	15.1	14.91	14.84	14.68
pH (standard units)	5 < x < 9	**7.1**	**7.0**	**7.1**	**6.88**	**6.90**	**6.58**
Conductivity (umhos)	NAp	1550	1110	950	1254	1437	1622
Turbidity (NTU)	NAp	0.2	1.7	2.7	1.05	0.20	0.45
Natural Attenuation Parameters							
Methane (ug/L)	> 500		2 U		ND	ND	**1,230**
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]		336		342	347	528
Total Organic Carbon (mg/L)	> 20		1.4		3	2	**39**
Nitrate, as N (mg/L)	< 1		**0.1 U**		**ND**	3	**ND**
Sulfate (mg/L)	< 20		170		173.0	126	**12.5**
Sulfide (mg/L)	>1		0.1 U		ND	ND	0.1
Chloride (mg/L)	>2X Backgnd [3]		**199**		**184**	**189**	**180**
Dissolved Oxygen (mg/L) [2]	< 0.5	1.60	**0.17**	0.54	2.41	1.49	1.19
Oxidation/Reduction Potential (mV) [2]	< 50	**-16**	**40**	90.60	88.6	78.2	**-138.1**
Ferrous Iron (mg/L) [2]	> 1		0.00		0.00	0.11	**10.40**

[1] From USEPA, 1998; These geochemical conditions represent a
[2] Field Measurement
[3] Background is 315 mg/L alkalinity and 73 mg/L chloride.
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U - Not detected
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ug/L - micrograms per liter
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MCL - Maximum contaminant level
umhos - microohms
NTU - nephelometric turbic
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-7
Monitoirng Well B354-99-11c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	B354-99-11c - 11 1/15/2002	B354-99-11c-22 4/25/2002	B354-99-11c-03 7/11/2002	B354-99-11c-11 3/17/2003	B354-99-11c/01 04/14/2004	B354-99-11c/02 08/17/2004
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70	**0.6**	0.5 U	0.5 U	0.5 U	**1.8**	**3.3**
Tetrachloroethylene (ug/L)	5	**11.7**	**10.4**	**10.3**	**12.3**	**11.8**	**9.7**
Trichloroethylene (ug/L)	5	**3.1**	**1.2**	**1.3**	**1.1**	**1.7**	**2**
Vinyl Chloride (ug/L)	2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Sample Number / Sampling Date	**Favorable Geochemical Conditions [1]**					**B354-99-11c 4/14/2004**	**B354-99-11c 8/17/2004**
Sampling Stabilization Parameters [2]							
Temperature (^{o}C)	> 20°C					15.2	16.3
pH (standard units)	5 < x < 9					**6.9**	**6.8**
Conductivity (umhos)	NAp					1,640	1,720
Turbidity (NTU)	NAp					1.01	0.32
Natural Attenuation Parameters							
Methane (ug/L)	> 500					2 U	NA
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd [3]					346	
Total Organic Carbon (mg/L)	> 20					1.2	NA
Nitrate, as N (mg/L)	< 1					2.2	NA
Sulfate (mg/L)	< 20					192	NA
Sulfide (mg/L)	>1					0.1 U	NA
Chloride (mg/L)	>2X Backgnd [3]					175	NA
Dissolved Oxygen (mg/L) [2]	< 0.5					0.87	0.85
Oxidation/Reduction Potential (mV) [2]	< 50					52	**39**
Ferrous Iron (mg/L) [2]	> 1					0.02	NA

[1] From USEPA, 1998; These geochemical conditions represent a
[2] Field Measurement
[3] Background is 315 mg/L alkalinity and 73 mg/L chloride.

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ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level
umhos - microohms
NTU - nephelometric turbidity units
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Table 5-7
Monitoirng Well B354-99-11c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL		B354-99-11c/01 9/29/2005	B354-99-11c/01 3/28/2006	B354-99-11c/01 10/3/2006	B354-99-11c/01 1/24/2007	B354-99-11c/01 4/18/2007
Contaminant of Concern Results							
cis-1,2-Dichloroethylene (ug/L)	70		**2.8**	**0.8**	**2.1**	**2.3**	**2.3**
Tetrachloroethylene (ug/L)	5		**11.2**	**11.1**	**9.2**	**8.7**	**8.7**
Trichloroethylene (ug/L)	5		**1.8**	**1**	**1.4**	**1.3**	**1.6**
Vinyl Chloride (ug/L)	2		0.5 U	0.5 U	0.8 U	0.8 U	0.8U

Sample Number / Sampling Date	Favorable Geochemical Conditions (1)	B354-99-11c 4/12/2005	B354-99-11c 9/29/2005	B354-99-11c 03/28/2006	B354-99-11c 10/3/2006	B354-99-11c 1/24/2007	B354-99-11c 04/18/2007
Sampling Stabilization Parameters (2)							
Temperature (°C)	> 20°C	15.3	15.7	15.80	15.81	13.17	16.06
pH (standard units)	5 < x < 9	**7.0**	**7.2**	**8.50**	**6.83**	**6.71**	**5.48**
Conductivity (umhos)	NAp	1,250	1,160	1,620	1,936	1,841	1,993
Turbidity (NTU)	NAp	1.1	3.1	1.87	0.55	1.24	7.10
Natural Attenuation Parameters							
Methane (ug/L)	> 500	2 U	NA	ND	ND	0.015	3.0
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)	343	NA	353	348	368	382
Total Organic Carbon (mg/L)	> 20	1.3	NA	1.3	1.3	1.9	2.8
Nitrate, as N (mg/L)	< 1	4.1	NA	5.7	4.2	2.3	1.7
Sulfate (mg/L)	< 20	189	· NA	187	187	192	204
Sulfide (mg/L)	>1	0.1 U	NA	ND	ND	ND	0.4
Chloride (mg/L)	>2X Backgnd (3)	**250**	NA	**305**	**321**	**290**	**300**
Dissolved Oxygen (mg/L) (2)	< 0.5	**0.18**	**0.12**	2.07	**0.24**	**0.31**	0.71
Oxidation/Reduction Potential (mV) (2)	< 50	92	59.50	62.0	60.1	**-151.6**	**-88.5**
Ferrous Iron (mg/L) (2)	> 1	0.01	NA	0.00	0.00	0.30	0.27

(1) From USEPA, 1998; These geochemical conditions represent a
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.

RSK - Risk Based Standards
Bold = Greater than KDHE RSK/MCL
Bold = Favorable Geochemical Conditions
KDHE - Kansas Department of Health and Environment

U - Not detected
ND - Not detected
ug/L - micrograms per liter
°C - degrees Celsius
MCL - Maximum contaminant level

umhos - microohms
NTU - nephelometric turbic
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Ta... 5-7
Monitoirng Well B354-99-11c
Groundwater Sampling Results (Historical and Recent)
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

Sample Number / Sampling Date	KDHE RSK/MCL	B354-99-11c/01 9/28/2007
Contaminant of Concern Results		
cis-1,2-Dichloroethylene (ug/L)	70	**8**
Tetrachloroethylene (ug/L)	5	1.1 U
Trichloroethylene (ug/L)	5	**1.3**
Vinyl Chloride (ug/L)	2	0.8 U

Sample Number / Sampling Date	Favorable Geochemical Conditions (1)	B354-99-11c 9/28/2007
Sampling Stabilization Parameters (2)		
Temperature (°C)	> 20°C	16.06
pH (standard units)	5 < x < 9	**7.03**
Conductivity (umhos)	NAp	2,190
Turbidity (NTU)	NAp	2.00
Natural Attenuation Parameters		
Methane (ug/L)	> 500	340.0
Alkalinity, as $CaCO_3$ (mg/L)	>2X Backgnd (3)	621
Total Organic Carbon (mg/L)	> 20	**32.9**
Nitrate, as N (mg/L)	< 1	**ND**
Sulfate (mg/L)	< 20	48
Sulfide (mg/L)	>1	ND
Chloride (mg/L)	>2X Backgnd (3)	**325**
Dissolved Oxygen (mg/L) (2)	< 0.5	**0.43**
Oxidation/Reduction Potential (mV) (2)	< 50	**-314.4**
Ferrous Iron (mg/L) (2)	> 1	0.30

(1) From USEPA, 1998; These geochemical conditions represent a
(2) Field Measurement
(3) Background is 315 mg/L alkalinity and 73 mg/L chloride.
RSK - Risk Based Standards
Bold = Greater than KDHE RSK/MCL
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MCL - Maximum contaminant level
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NTU - nephelometric turbic
mg/L - milligrams per liter
mV - millivolts
NAp - Not Applicable

Figures

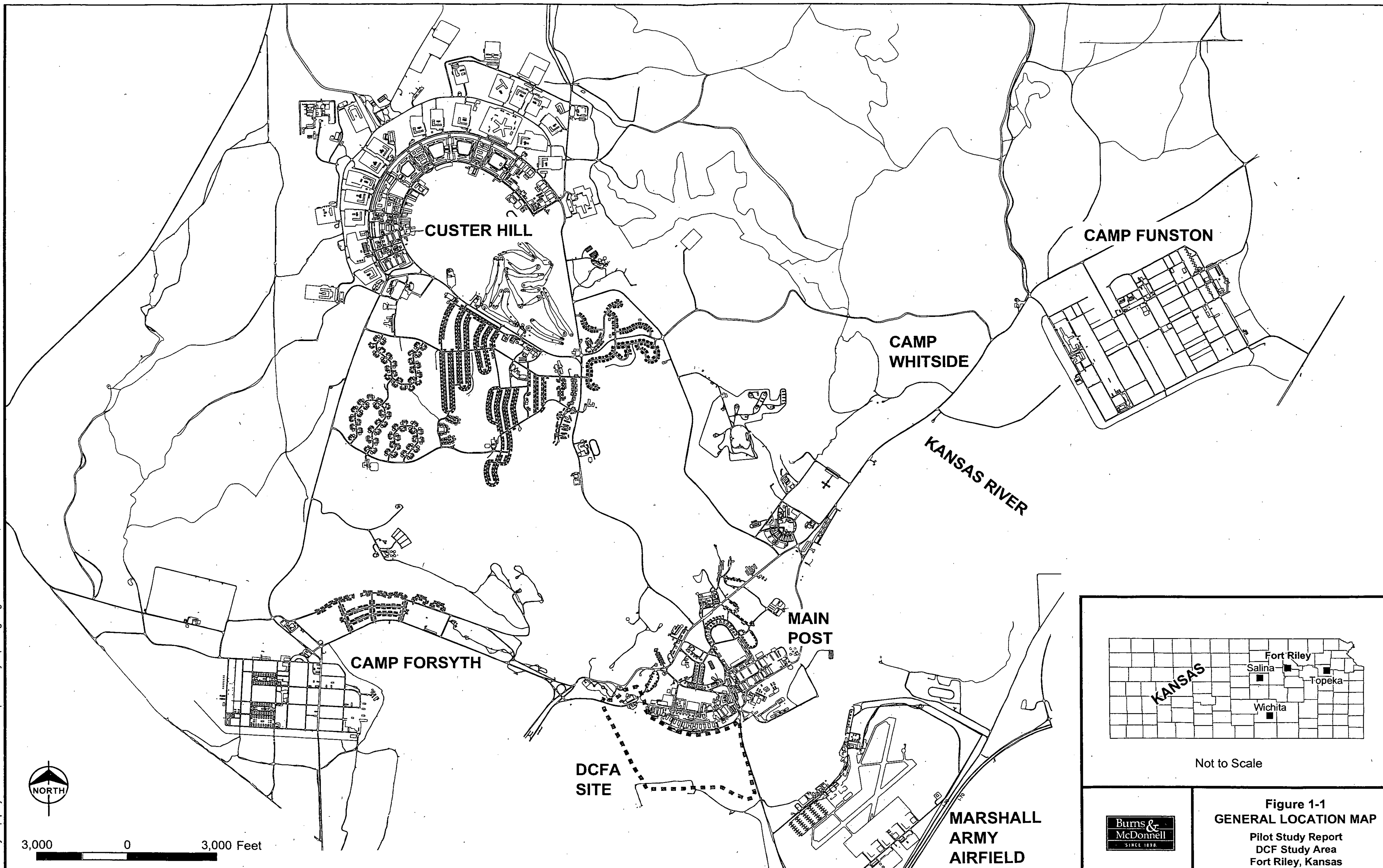

Figure 1-1
GENERAL LOCATION MAP
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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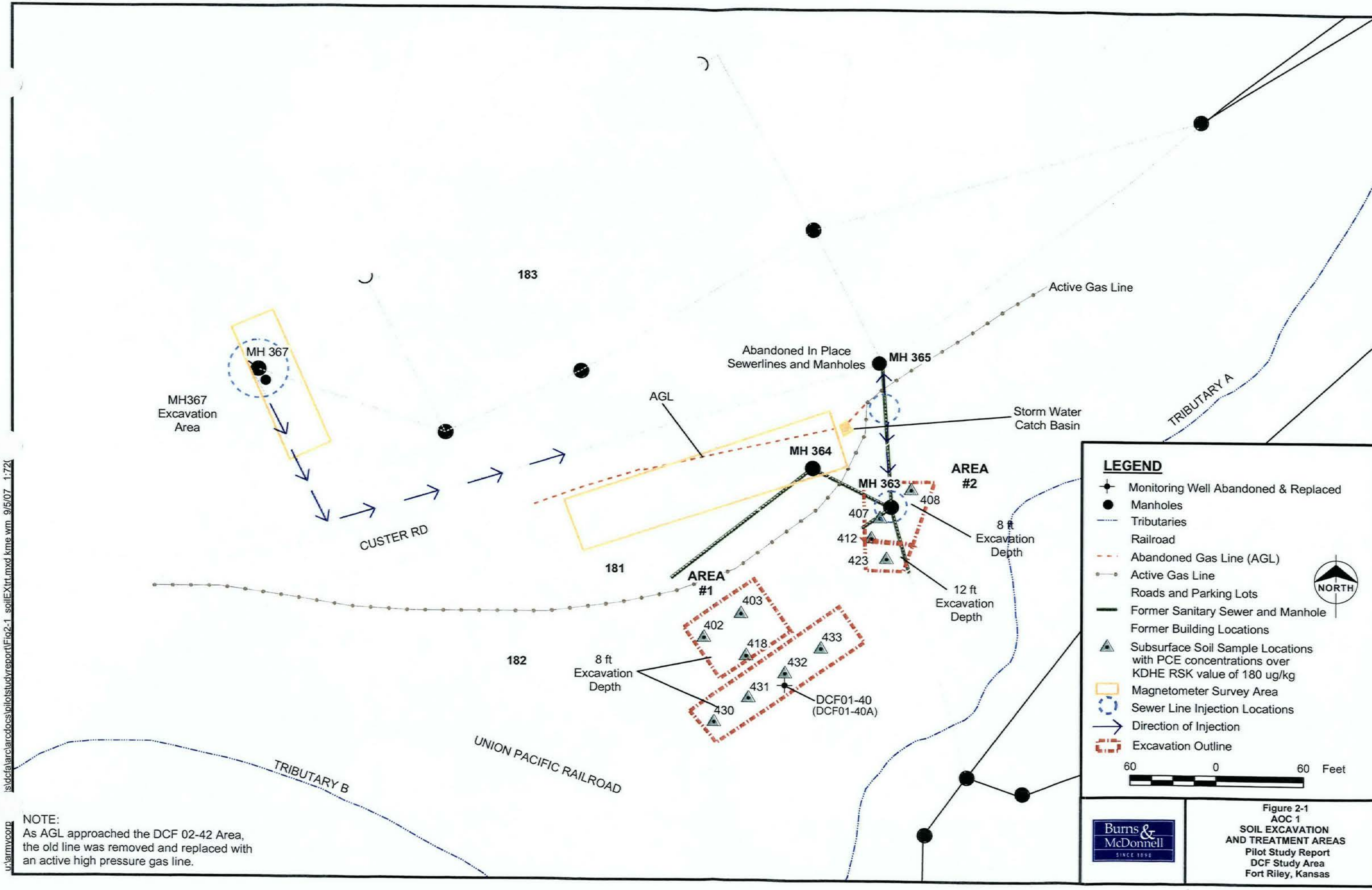

NOTE:
As AGL approached the DCF 02-42 Area, the old line was removed and replaced with an active high pressure gas line.

Figure 2-1
AOC 1
SOIL EXCAVATION
AND TREATMENT AREAS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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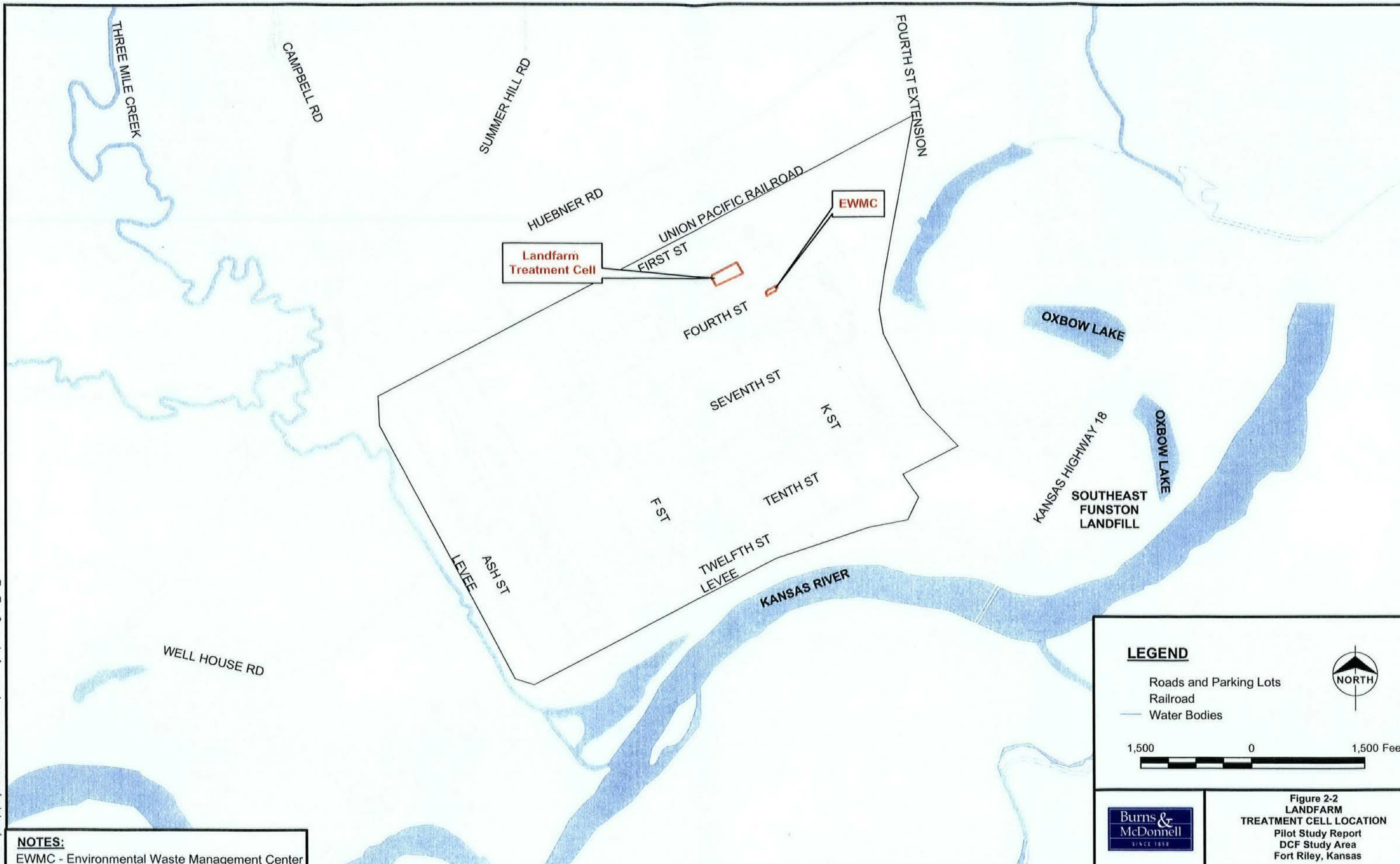

NOTES:
EWMC - Environmental Waste Management Center

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Figure 2-2
LANDFARM
TREATMENT CELL LOCATION
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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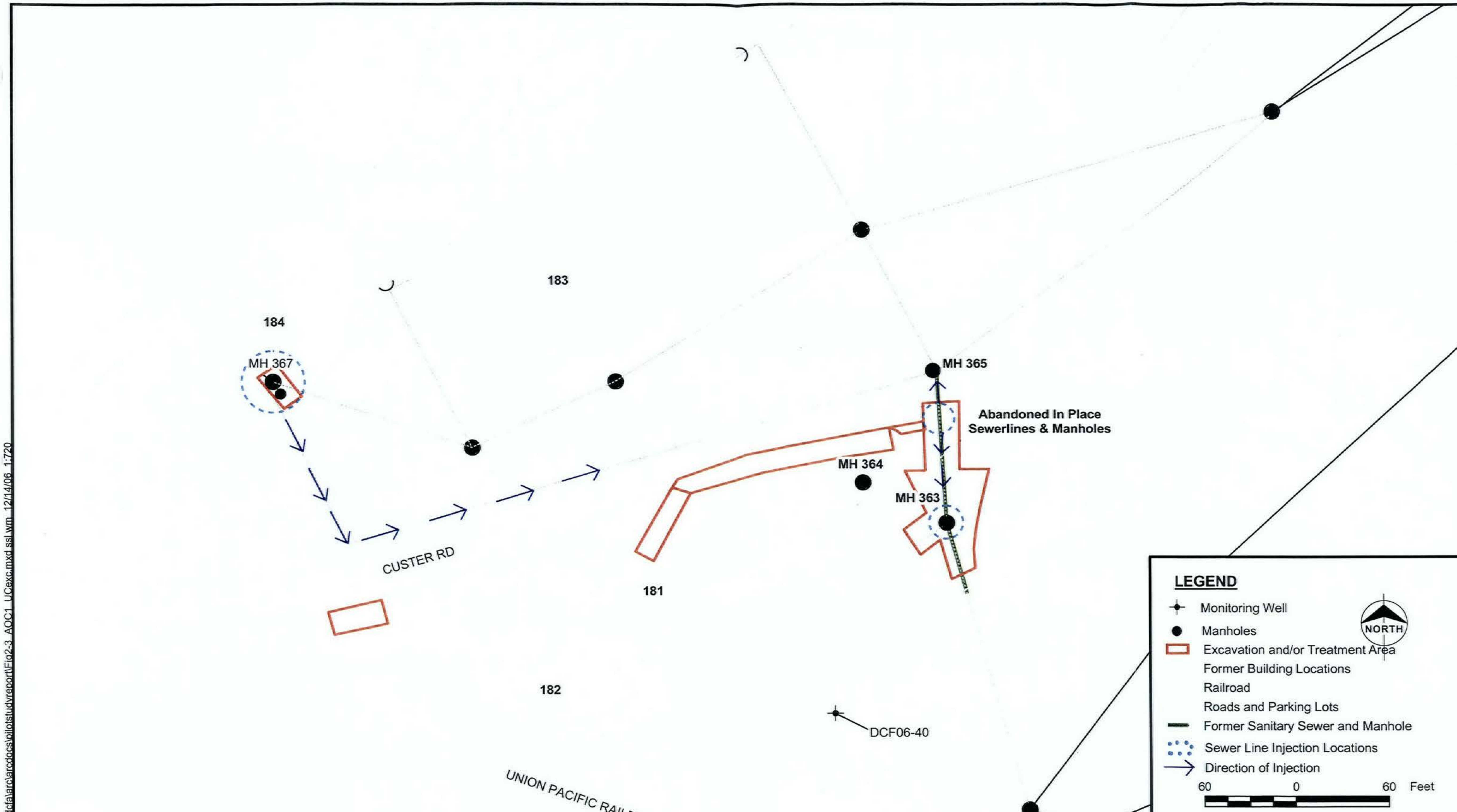

Figure 2-3
AOC 1
UTILITY CORRIDOR
EXCAVATION AND TREATMENT AREAS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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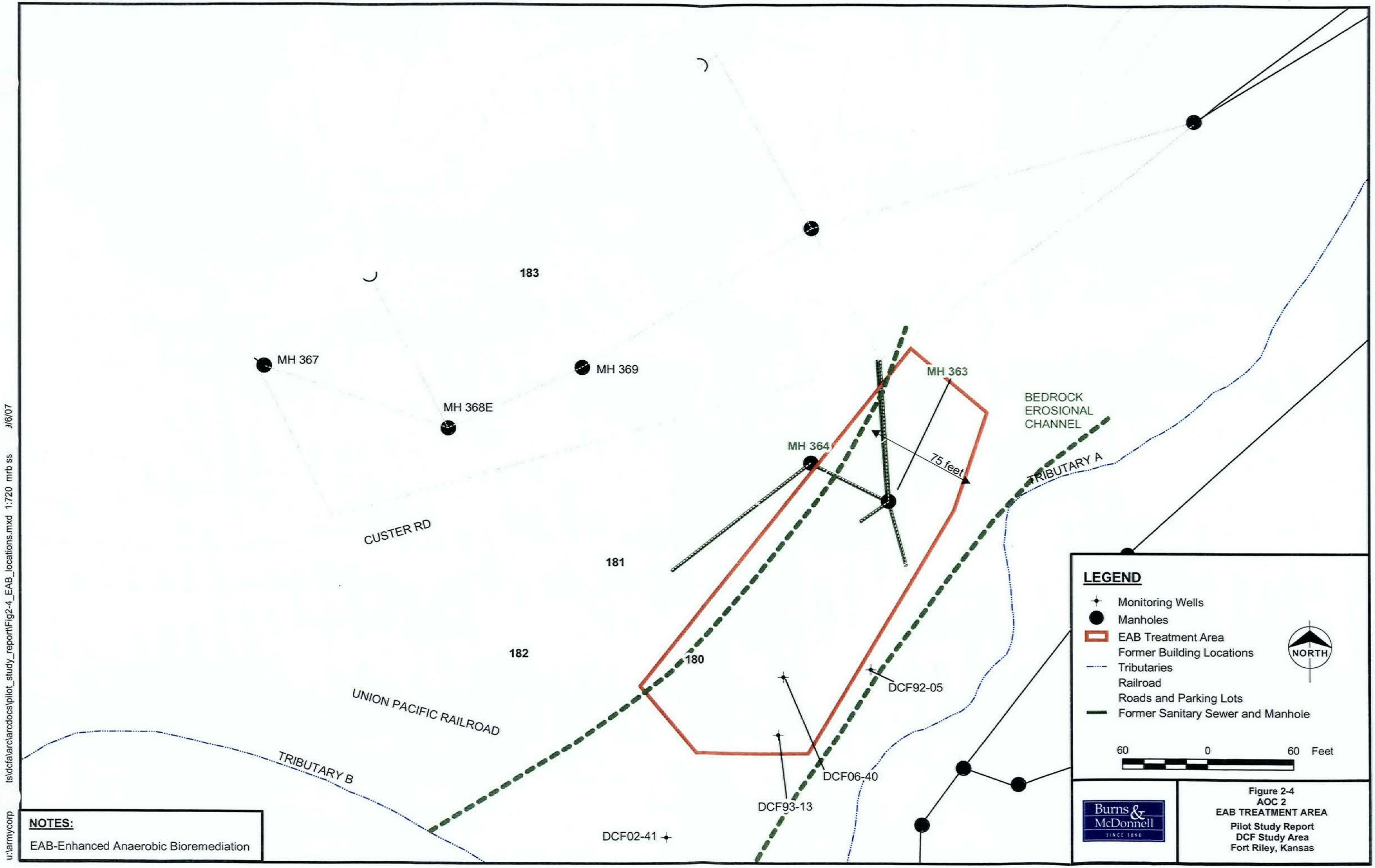

183
MH 367
MH 369
MH 368E
MH 363
MH 364
BEDROCK
EROSIONAL
CHANNEL
75 feet
TRIBUTARY A
CUSTER RD
181
182
180
UNION PACIFIC RAILROAD
TRIBUTARY B
DCF92-05
DCF06-40
DCF93-13
DCF02-41
LEGEND
Monitoring Wells
Manholes
EAB Treatment Area
Former Building Locations
Tributaries
Railroad
Roads and Parking Lots
Former Sanitary Sewer and Manhole
NORTH
60 0 60 Feet
NOTES:
EAB-Enhanced Anaerobic Bioremediation
Burns & McDonnell
SINCE 1898
Figure 2-4
AOC 2
EAB TREATMENT AREA
Pilot Study Report
DCF Study Area
Fort Riley, Kansas
u:\armycorp ts\dcfa\arcdocs\pilot_study_report\Fig2-4_EAB_locations.mxd 1:720 mrb ss 3/6/07

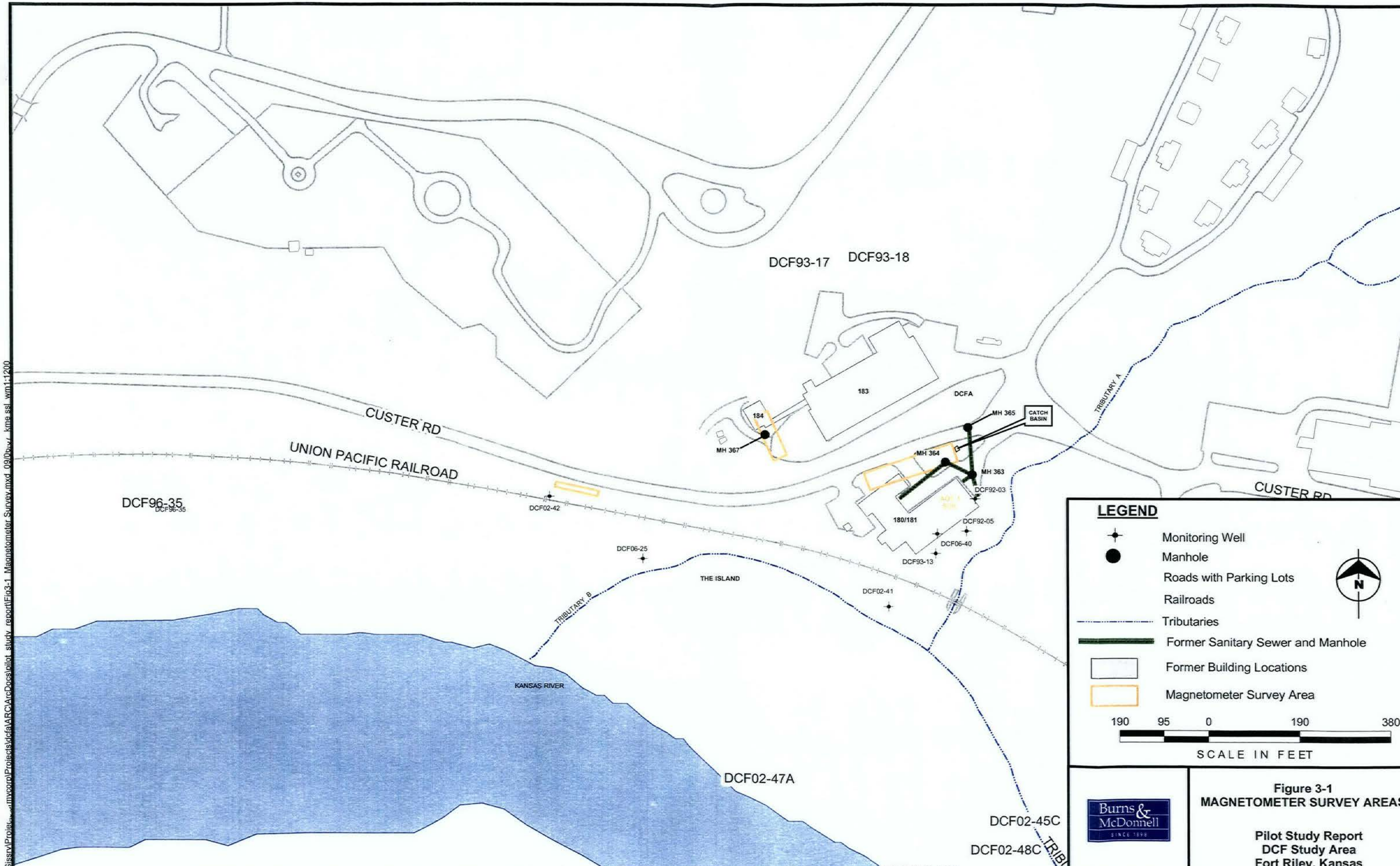

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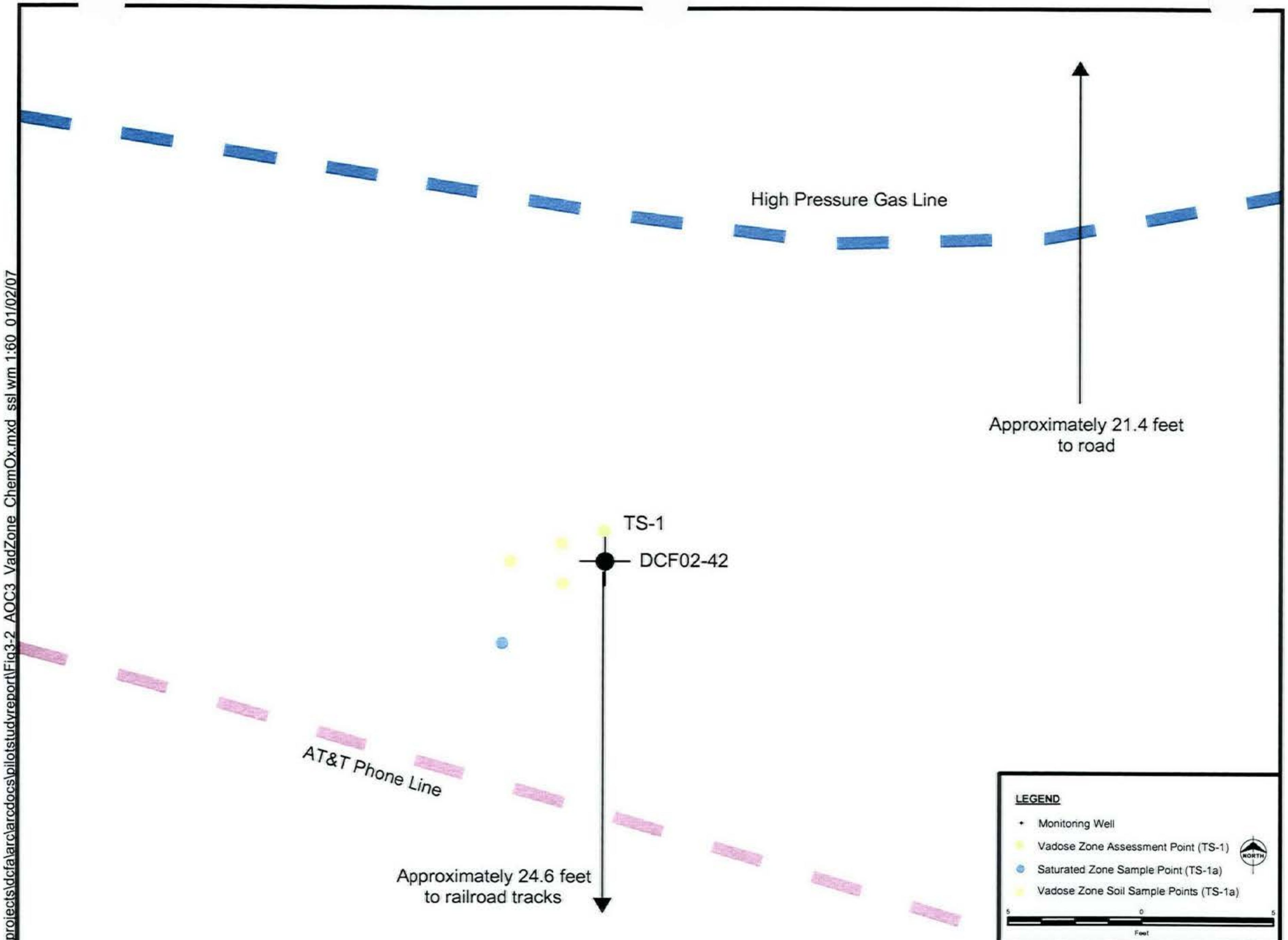
Figure 3-1
MAGNETOMETER SURVEY AREAS

Pilot Study Report
DCF Study Area
Fort Riley, Kansas

\\Gissrv\Projects\...mvcorp\Projects\dcfa\ARC\ArcDocs\pilot_study_report\Fig3-1_Magnetometer_Survey.mxd 09/0...kme ssl wm1:1200



Burns & McDonnell

Figure 3-2
AOC 3
VADOSE ZONE CHEMICAL OXIDATION
TREATMENT LOCATIONS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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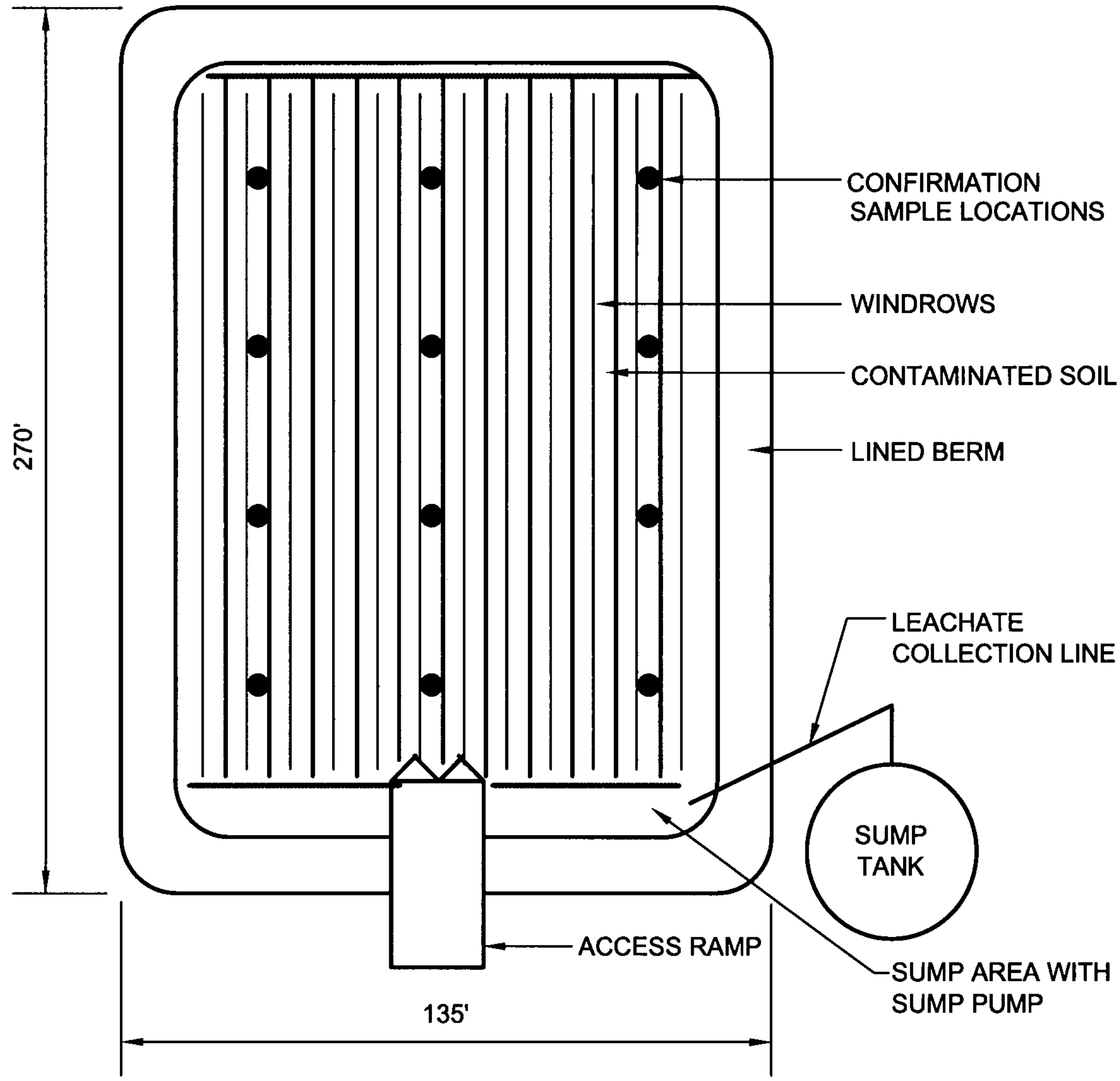
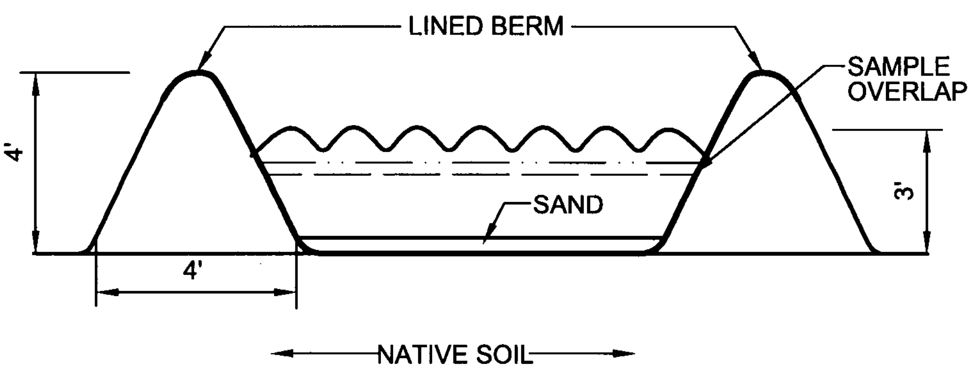


PLAN VIEW



CROSS SECTION

LEGEND

— — TILLING DEPTH - 18 INCHES

— · · — SAMPLE DEPTH - 12 INCHES

Burns & McDonnell SINCE 1898	Figure 3-3 LANDFARM TREATMENT CELL PILOT STUDY REPORT DCF STUDY AREA FORT RILEY, KANSAS

K:\ENV\ECC\site\40904\Cod\DET-FG3-3.dwg 09-07-2007 14:07 KME

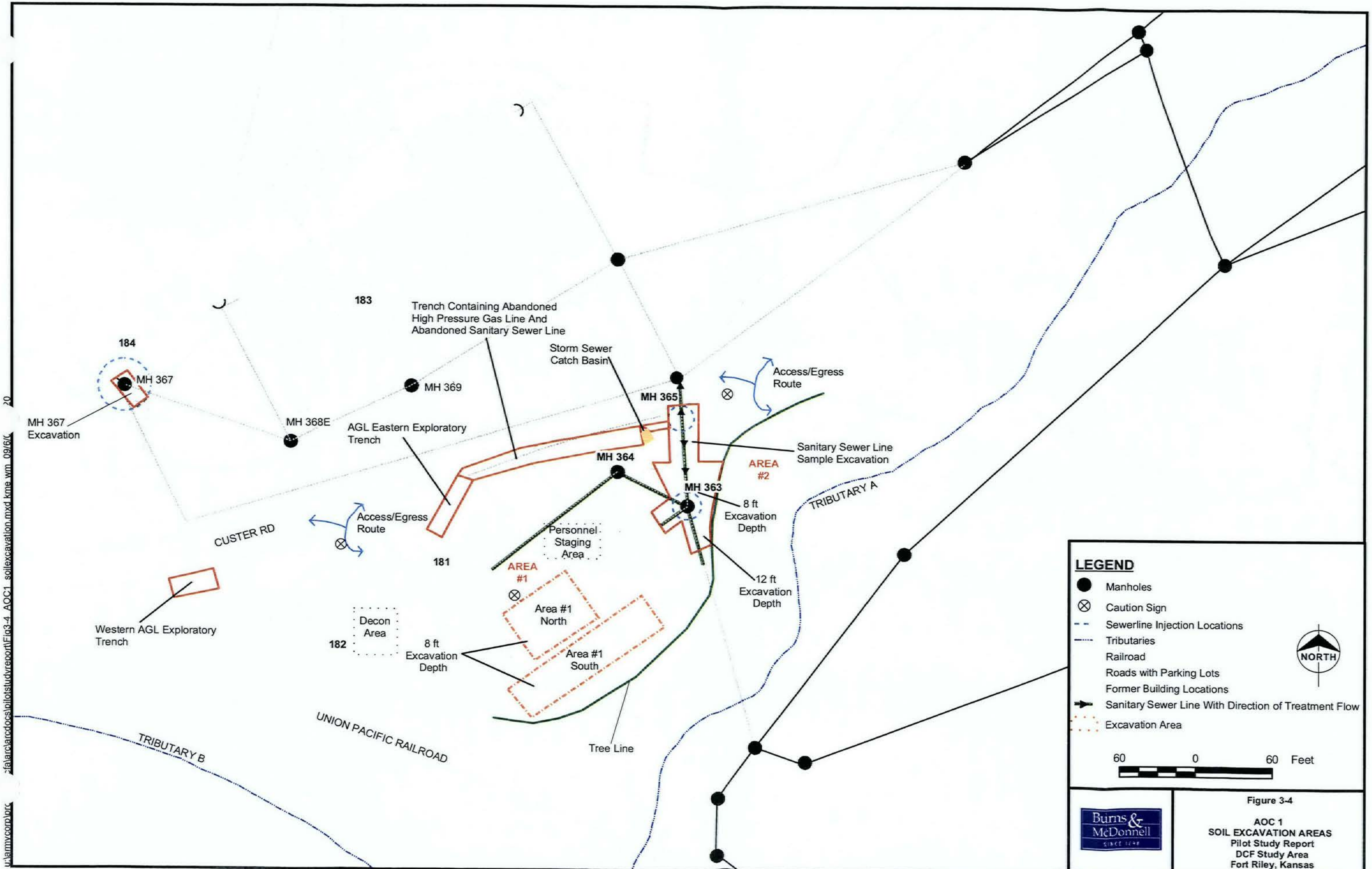


Figure 3-4

AOC 1
SOIL EXCAVATION AREAS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

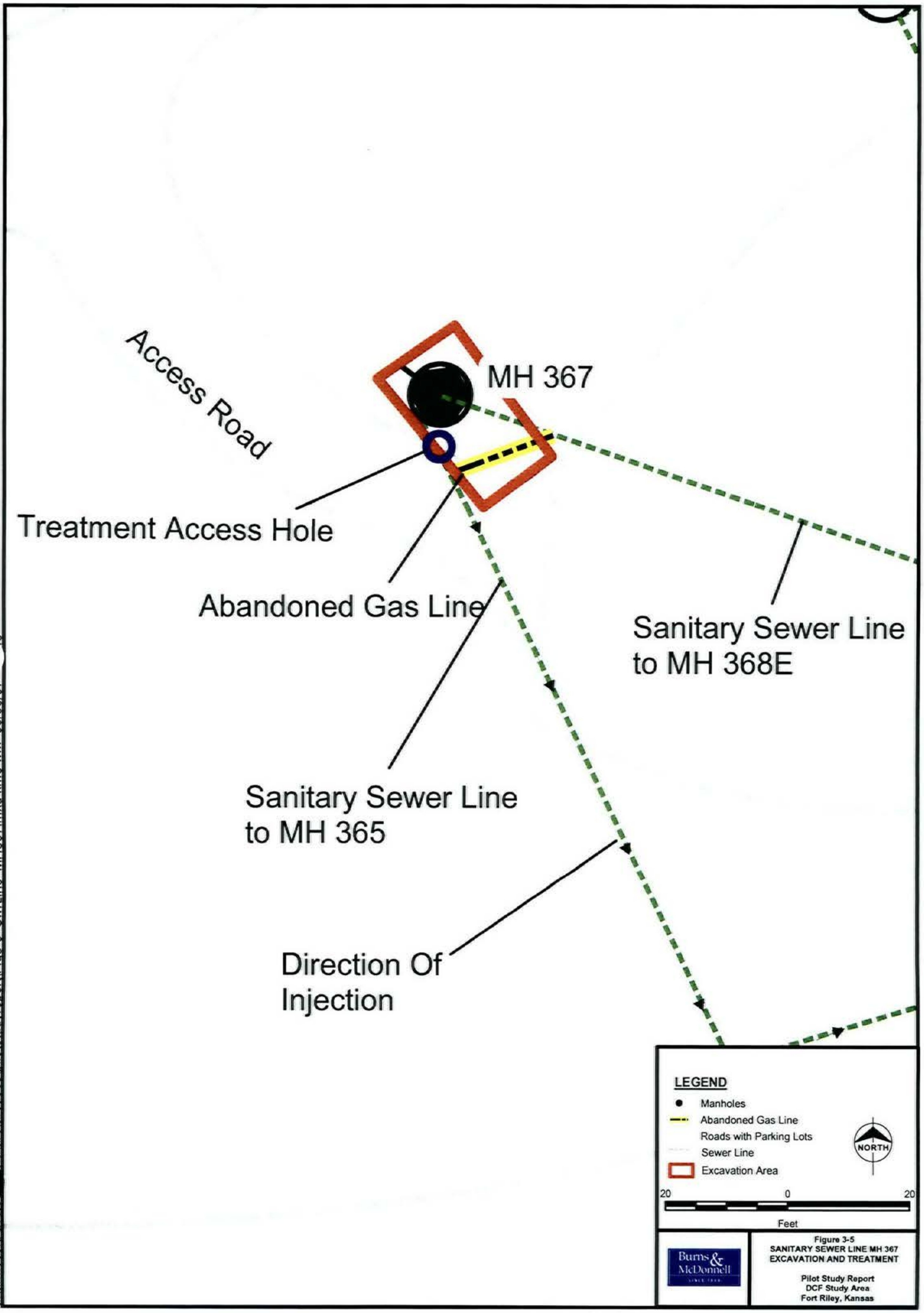


Figure 3-5
SANITARY SEWER LINE MH 367
EXCAVATION AND TREATMENT

Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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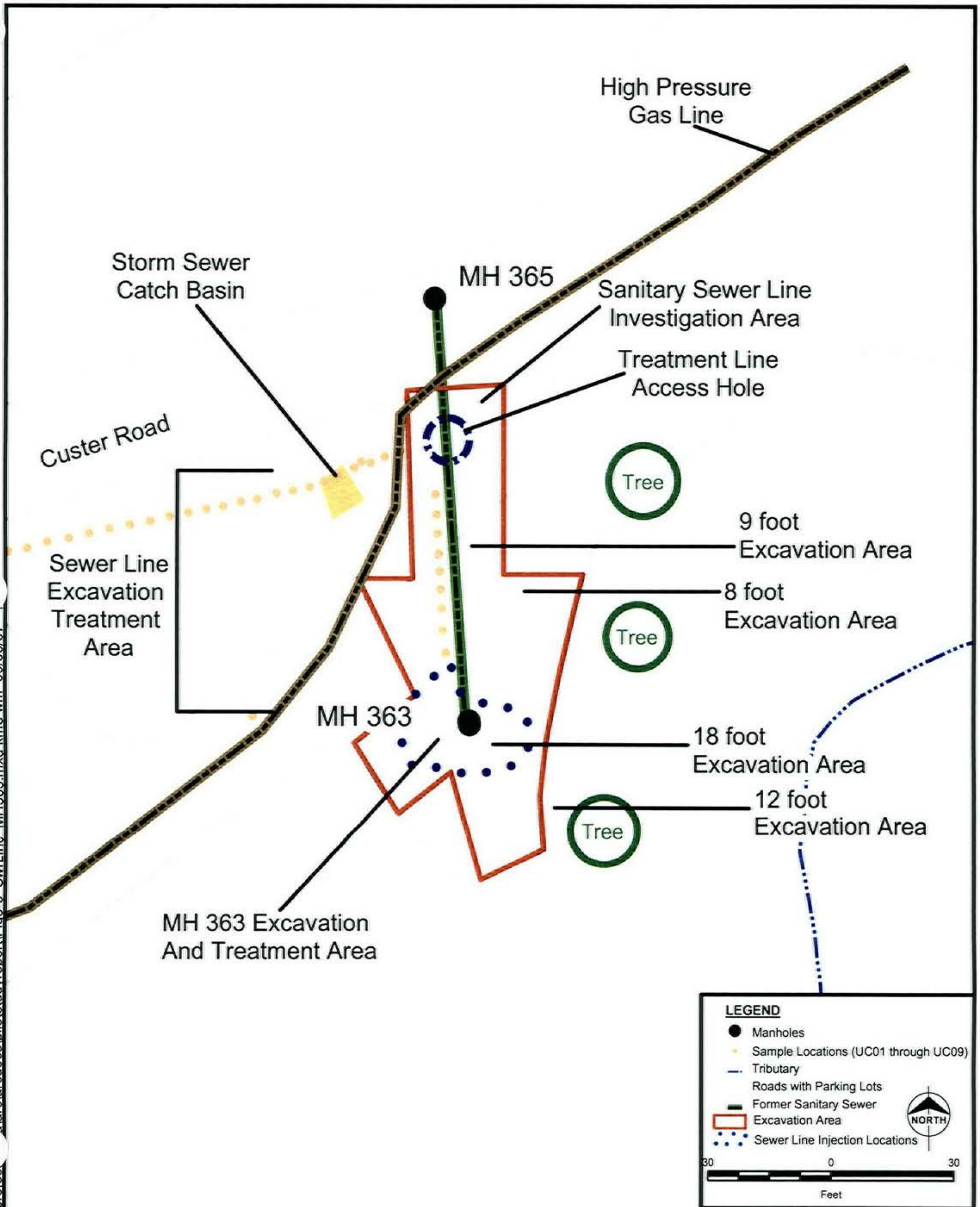

Burns & McDonnell

Figure 3-6
SANITARY SEWER LINE & MH 363 EXCAVATION AND TREATMENT
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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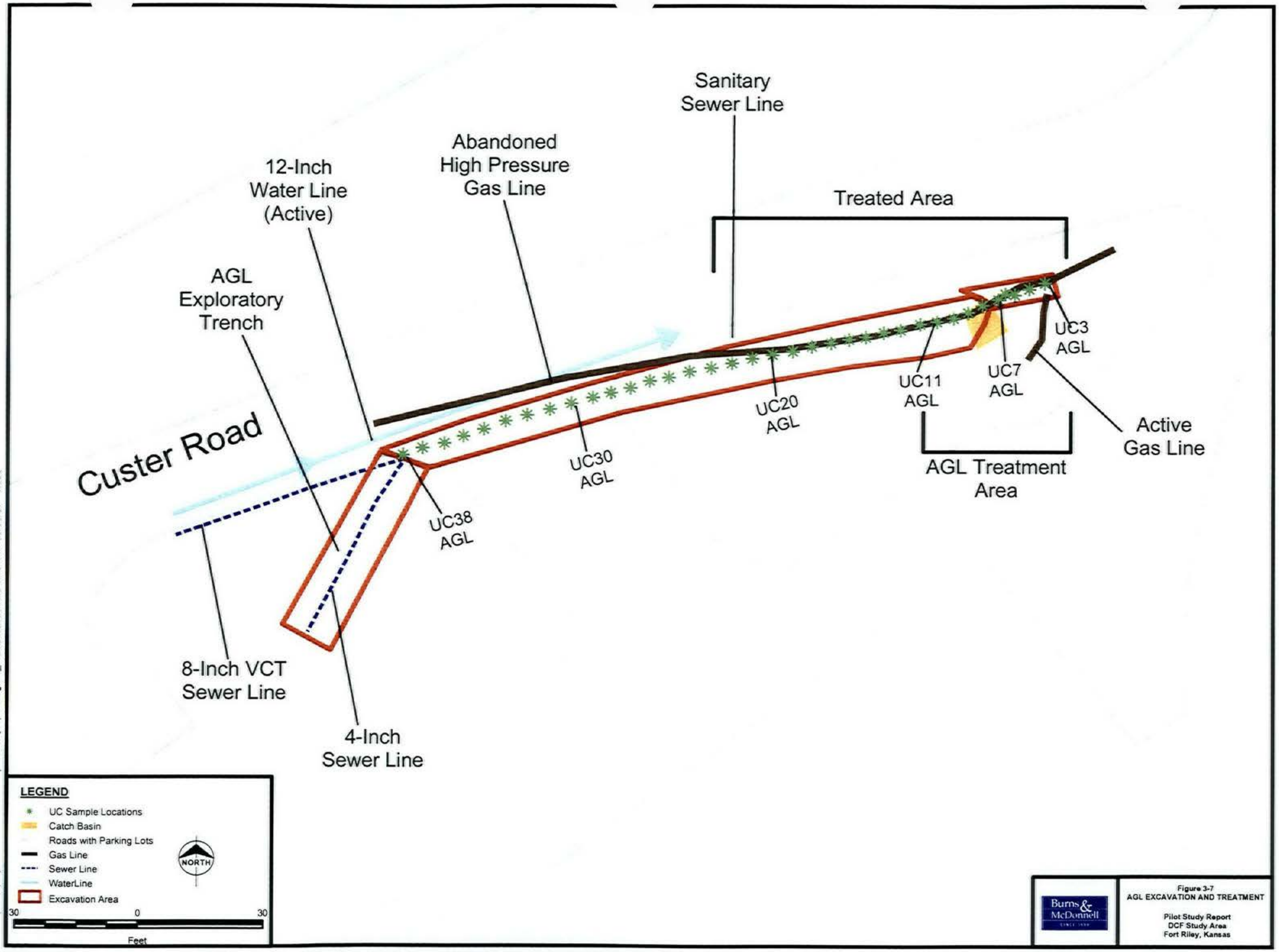

Figure 3-7
AGL EXCAVATION AND TREATMENT

Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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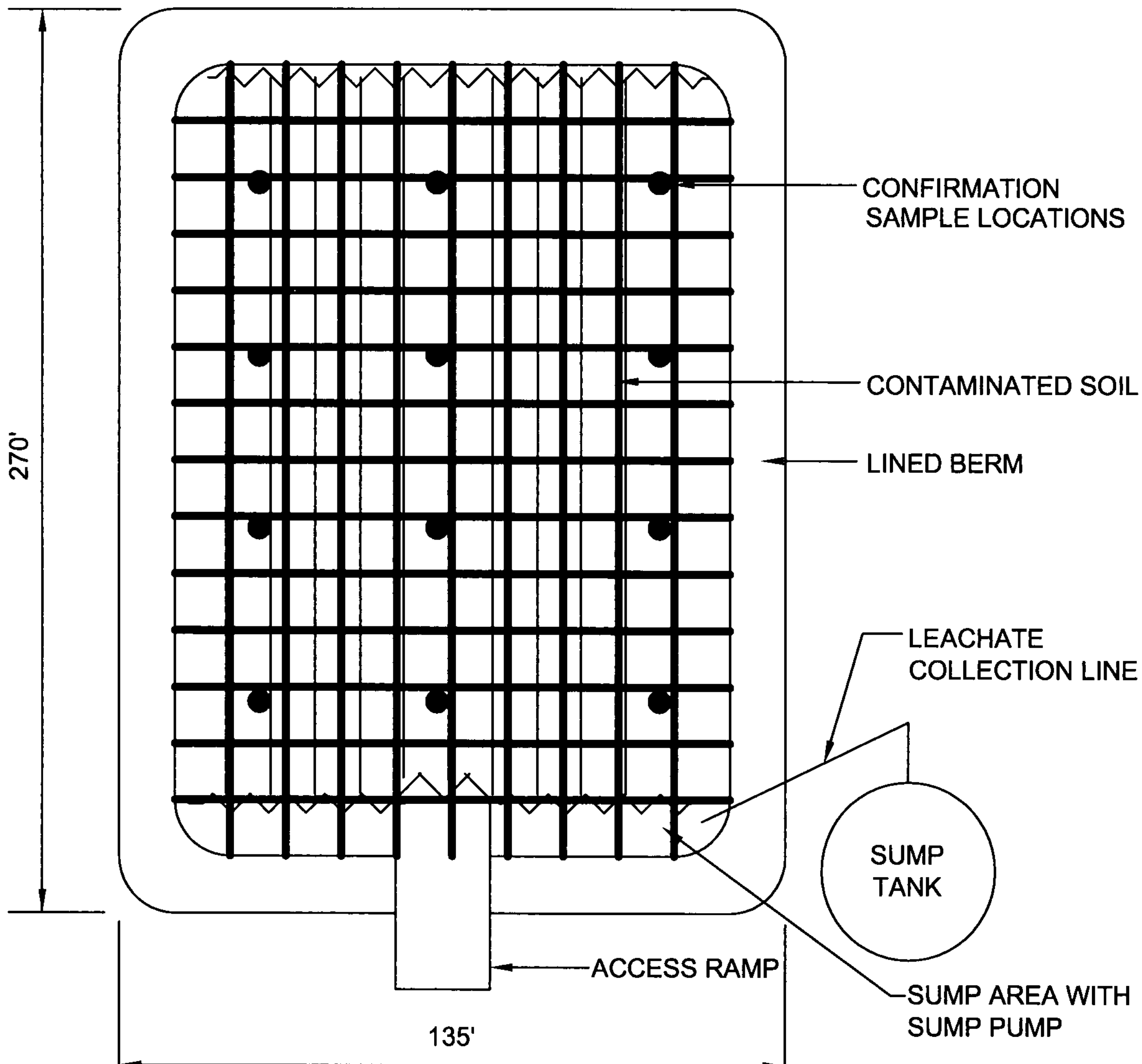

PLAN VIEW

LEGEND

SOIL REMOVAL GRID

Burns & McDonnell SINCE 1898

Figure 3-8
TREATMENT CELL SAMPLING GRID
PILOT STUDY REPORT
DCF STUDY AREA
FORT RILEY, KANSAS

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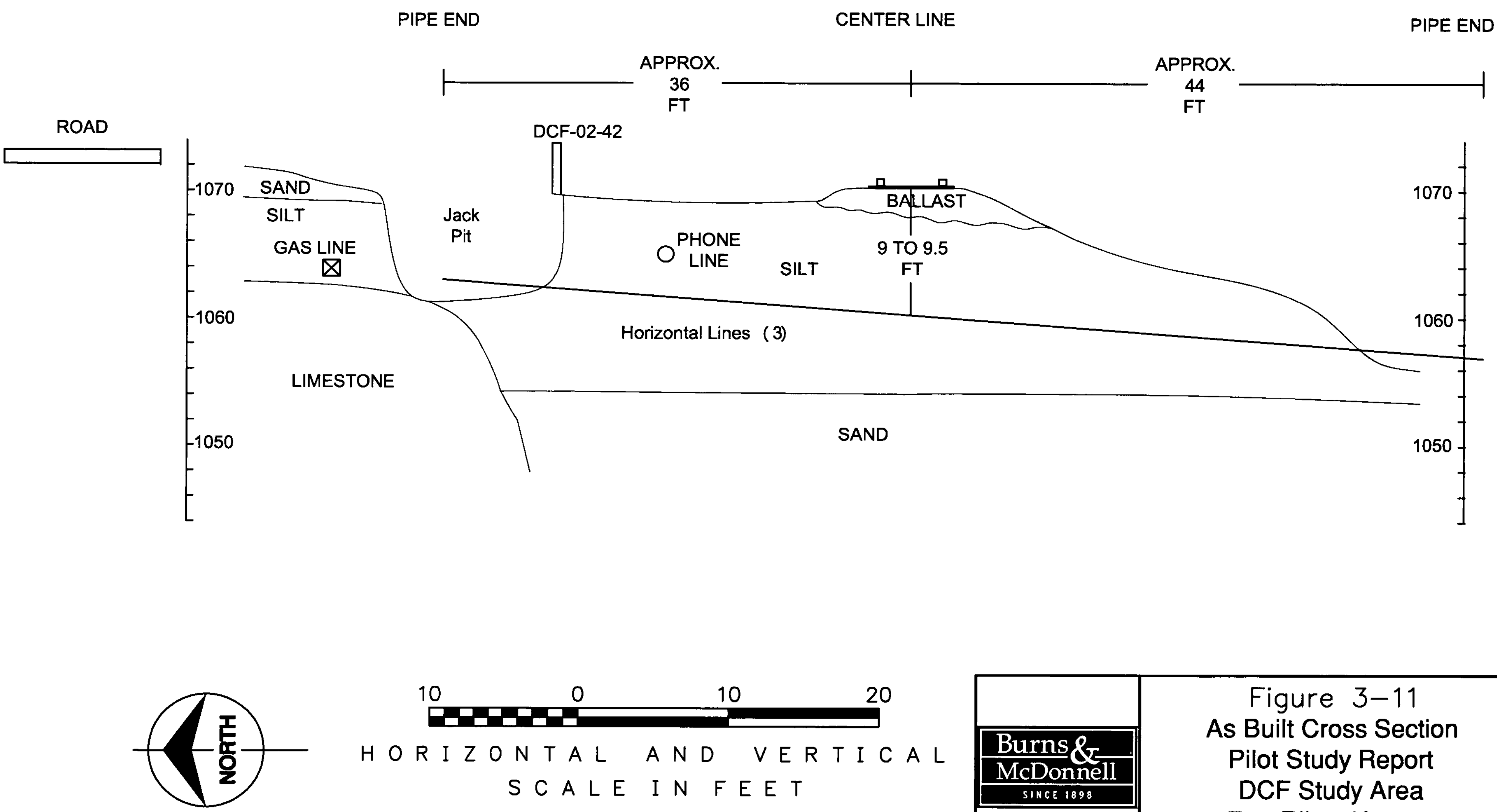
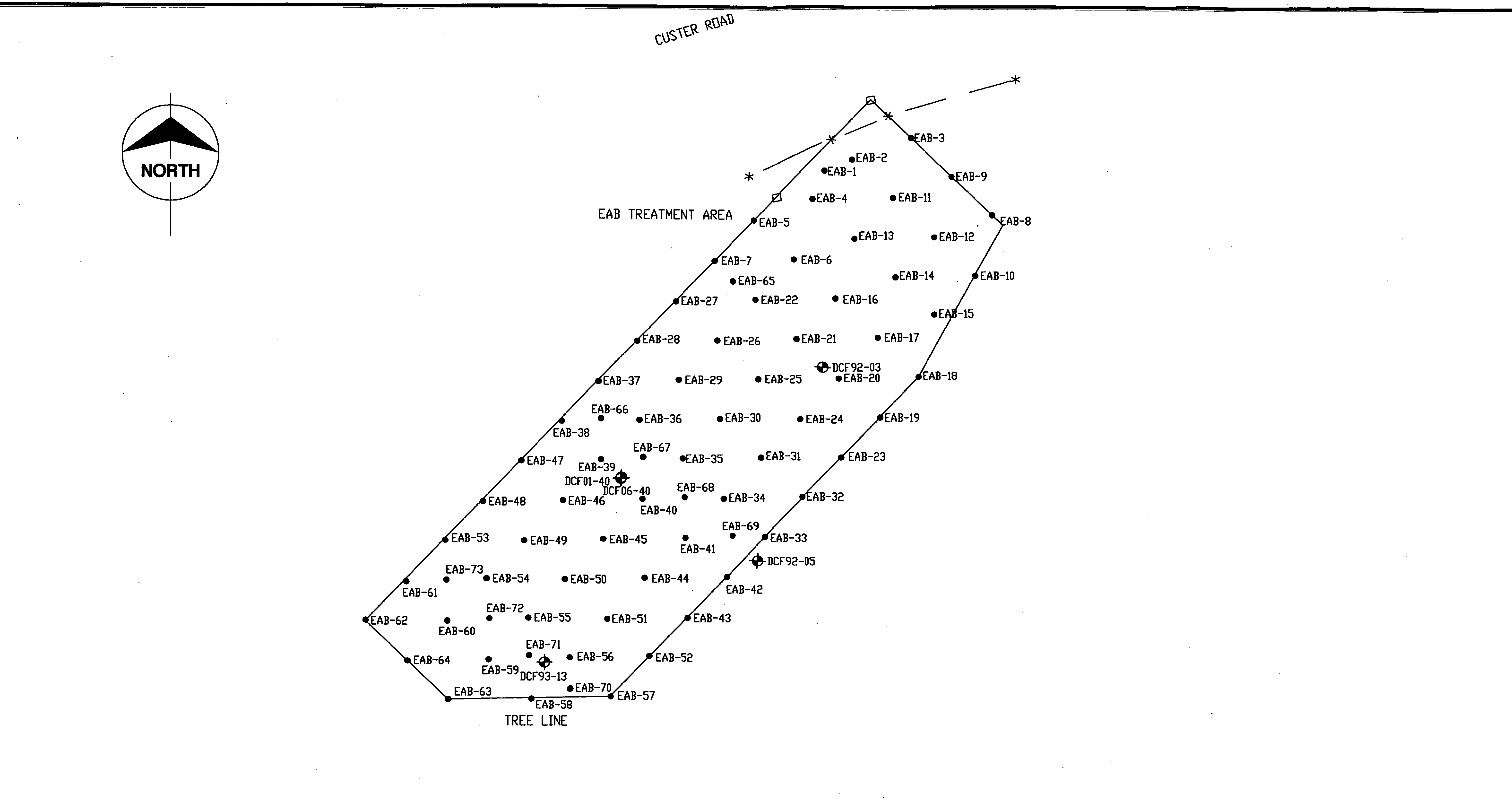


Burns & McDonnell
SINCE 1898

Figure 3–11
As Built Cross Section
Pilot Study Report
DCF Study Area
Fort Riley, Kansas



LEGEND

—✕——✕— GAS LINE

• PROPOSED INJECTION POINT

DCF93-13 MONITORING WELL

NOTES

- 73 TOTAL INJ. POINTS (15 GAL CAP 18 PER POINT)

30 0 30 60

SCALE IN FEET

Burns & McDonnell SINCE 1898

Figure 3-12
AOC 2 EAB Injection Locations
DCF Study Area
Pilot Study Report
Fort. Riley, Kansas

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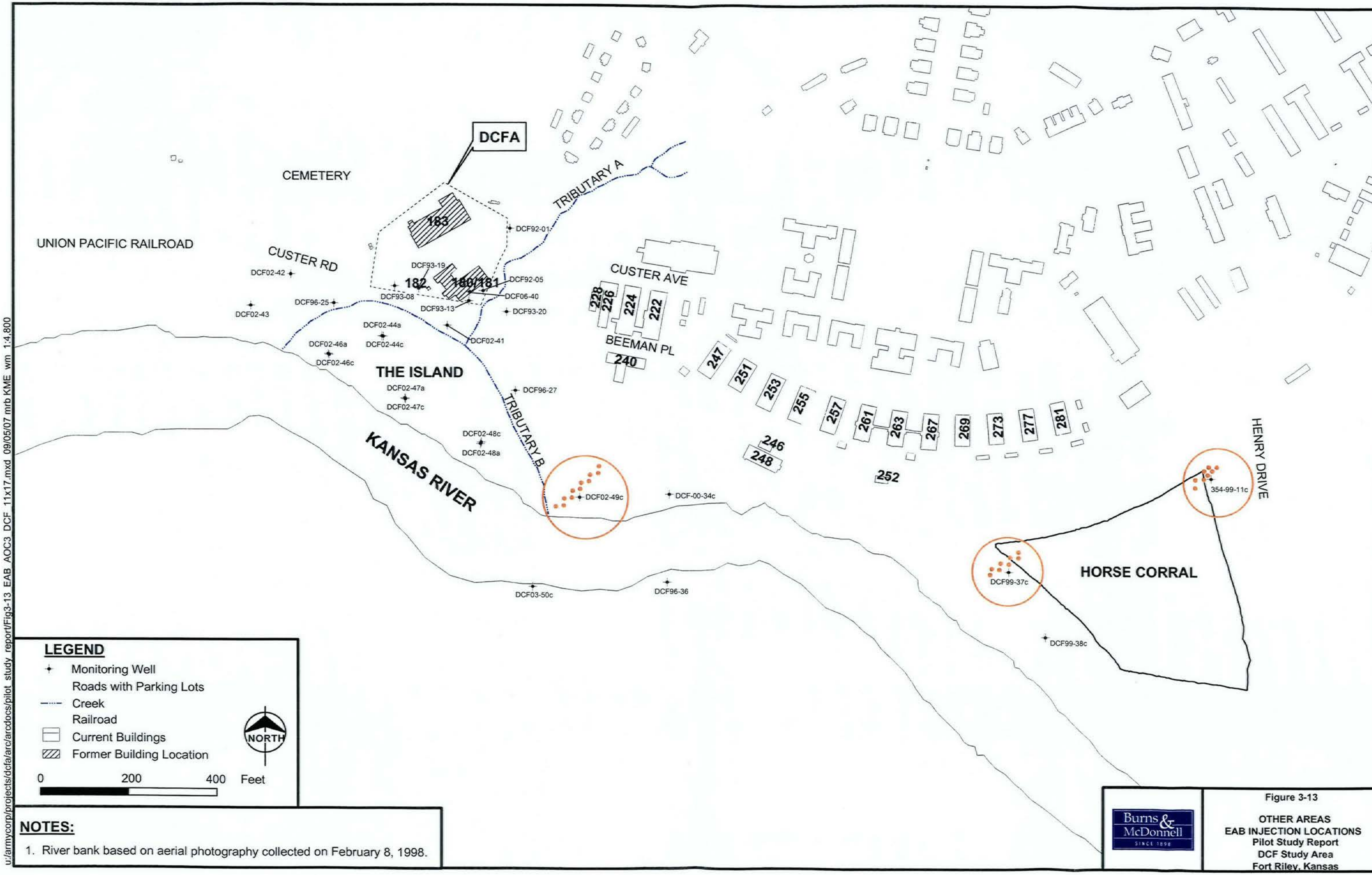

Figure 3-13

OTHER AREAS
EAB INJECTION LOCATIONS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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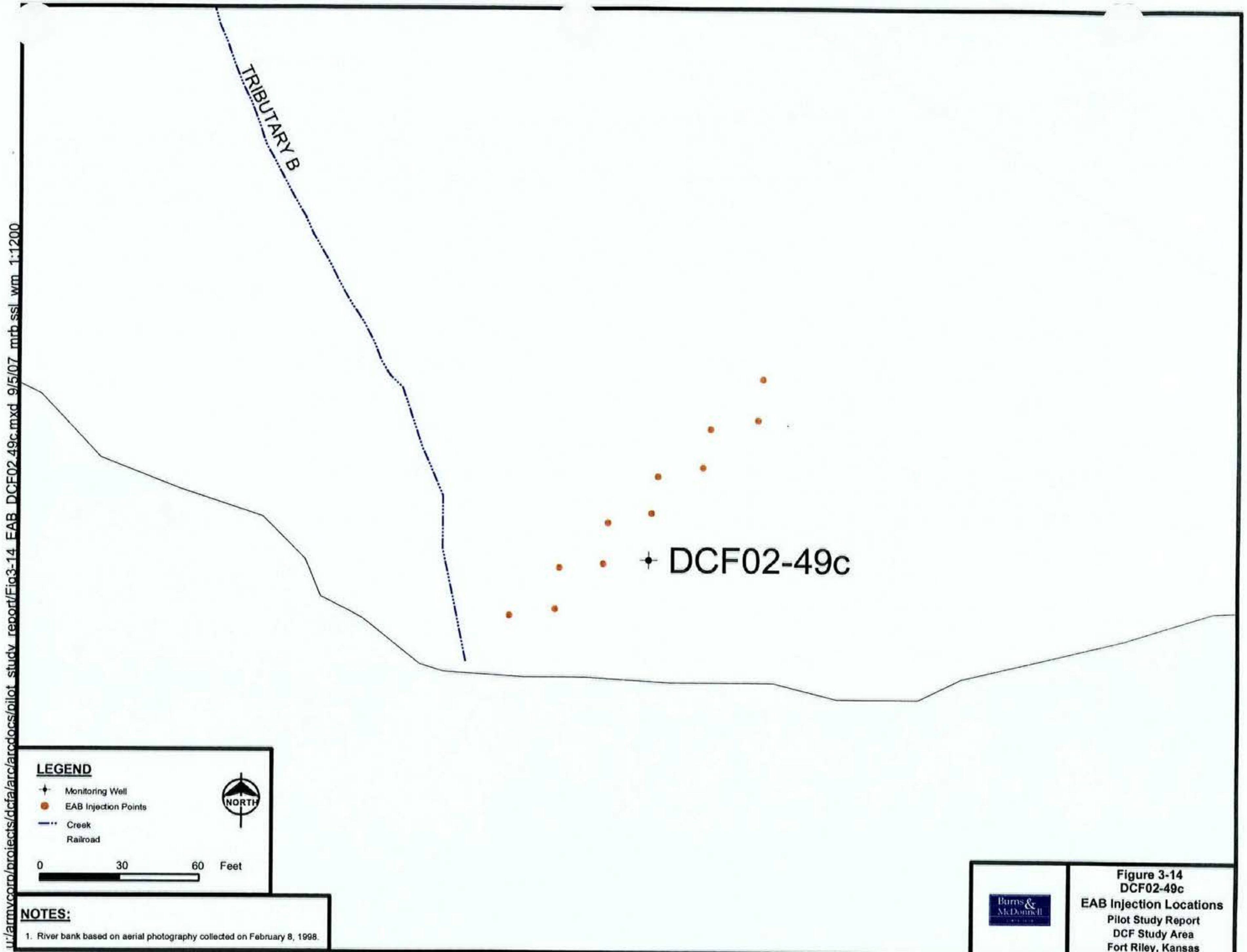

Figure 3-14
DCF02-49c
EAB Injection Locations
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

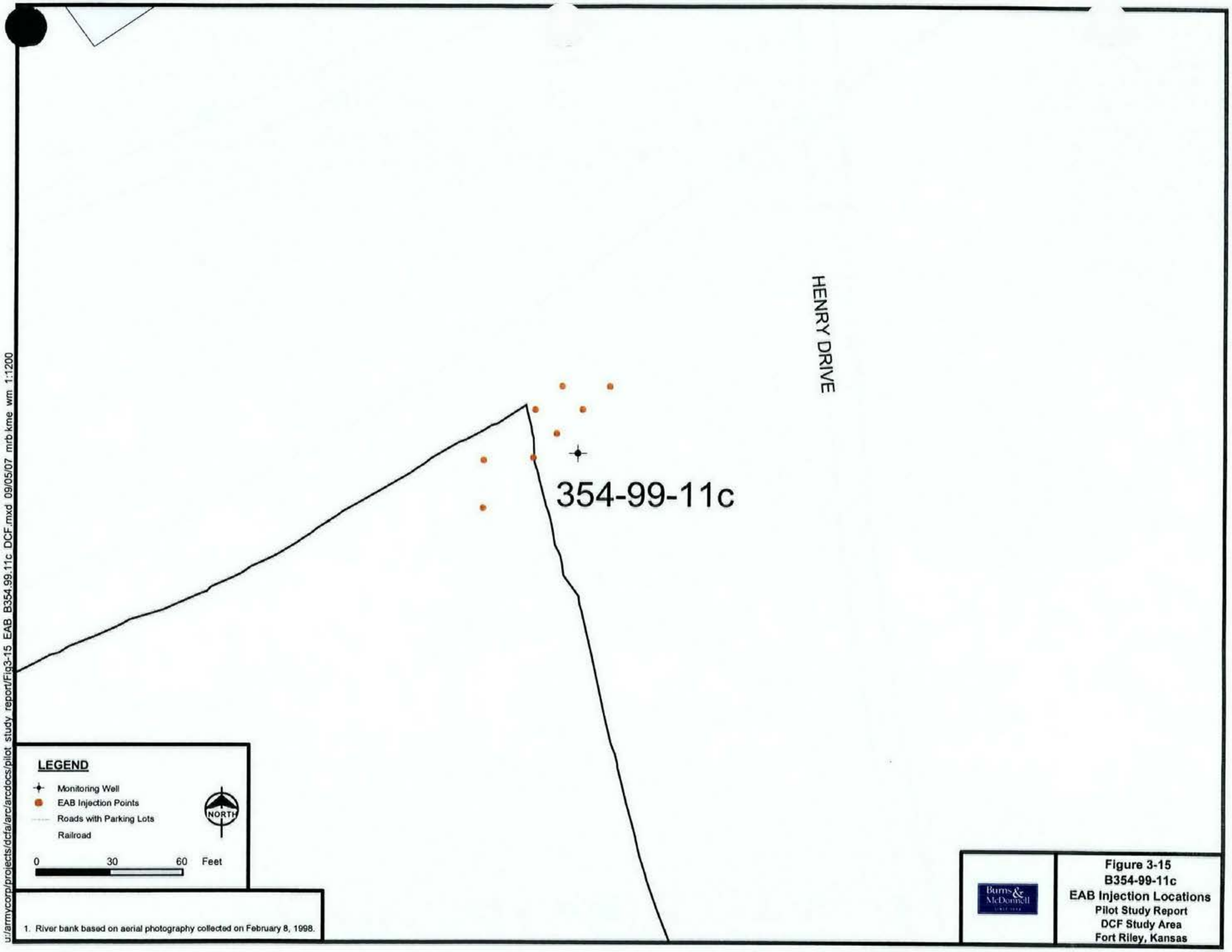

Figure 3-15
B354-99-11c
EAB Injection Locations
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

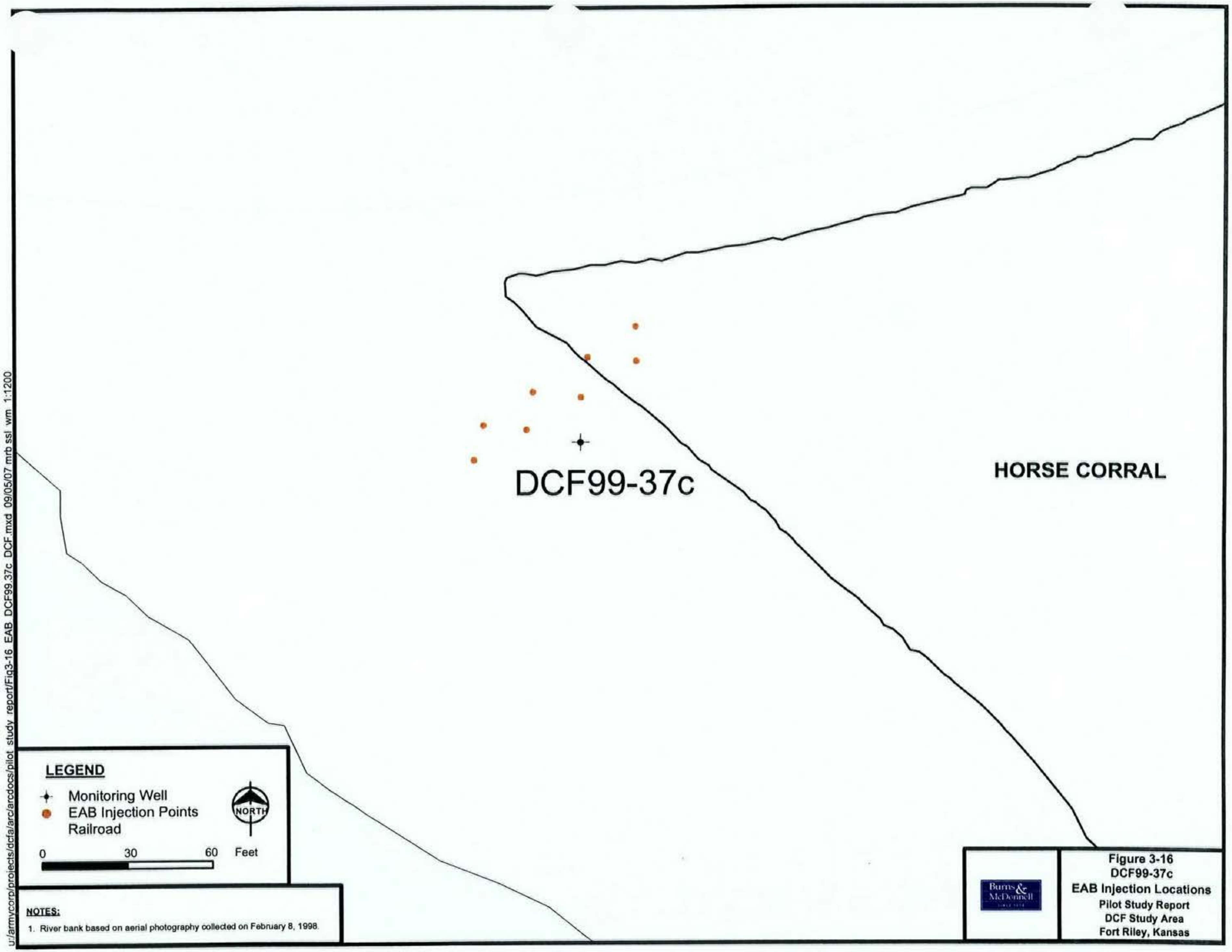

Figure 3-16
DCF99-37c
EAB Injection Locations
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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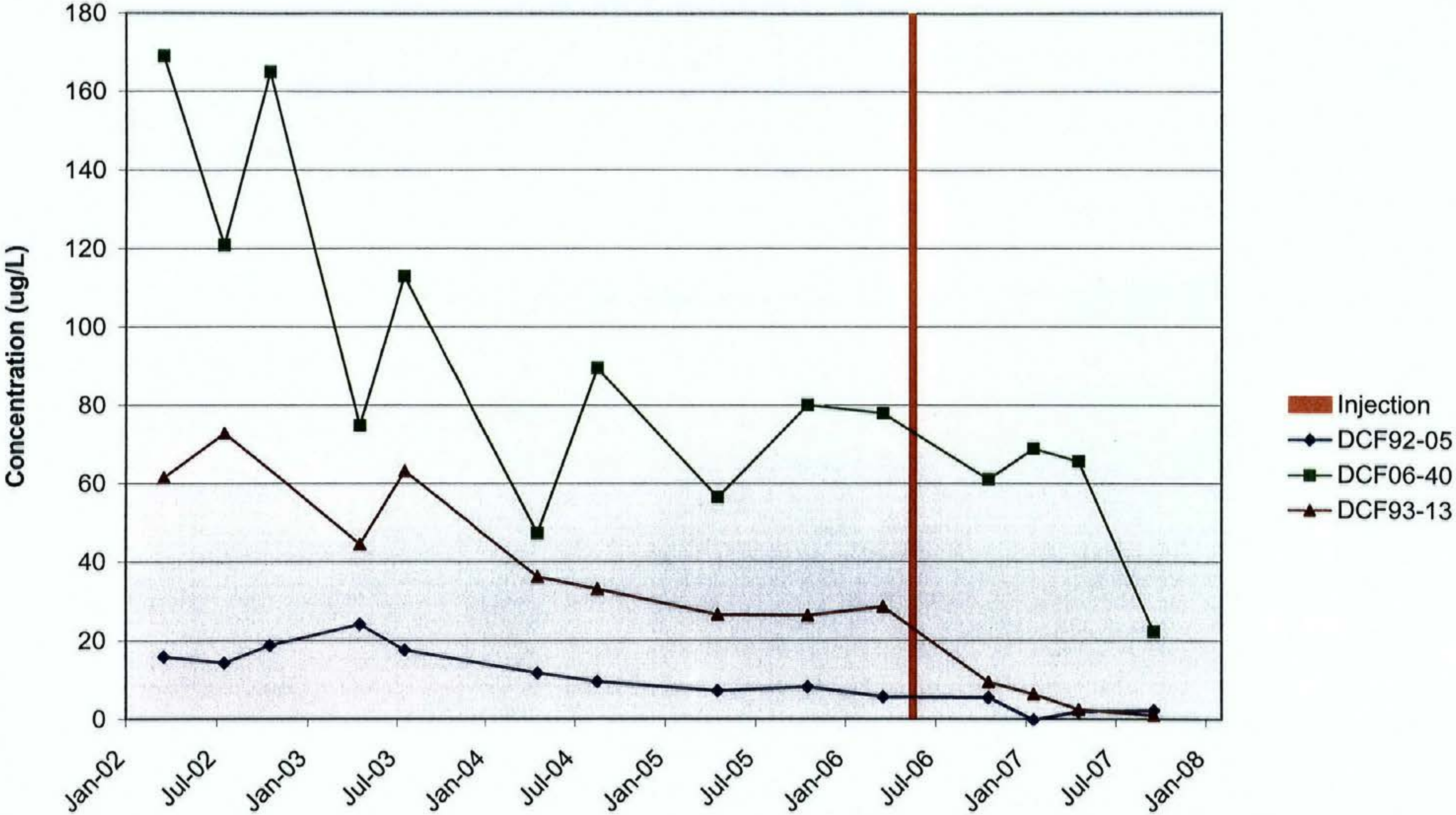


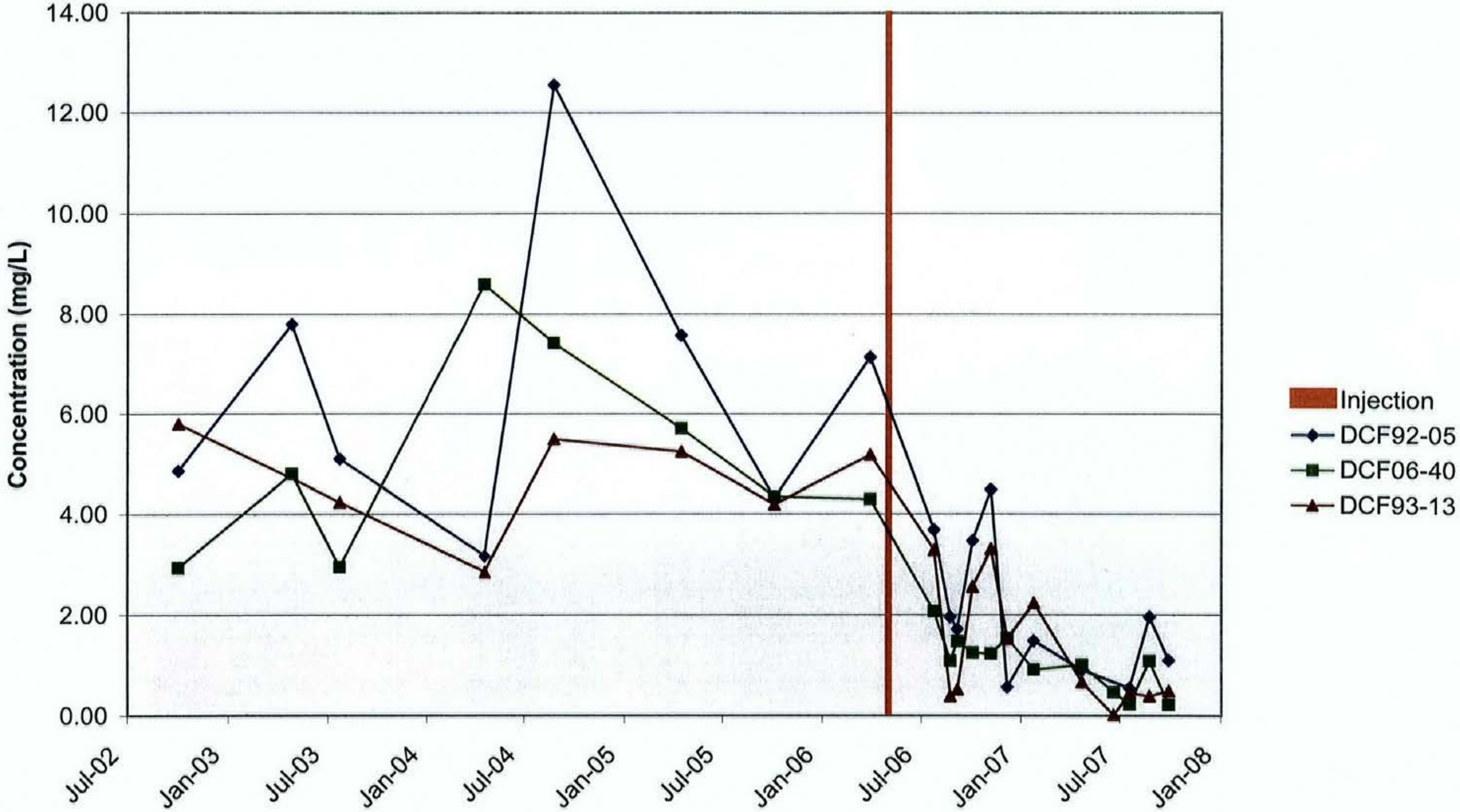
Burns & McDonnell SINCE 1898

Figure 5 -1

PCE CONCENTRATIONS
AOC 2

DCF Site, Fort Riley, Kansas

Tables section5.xls



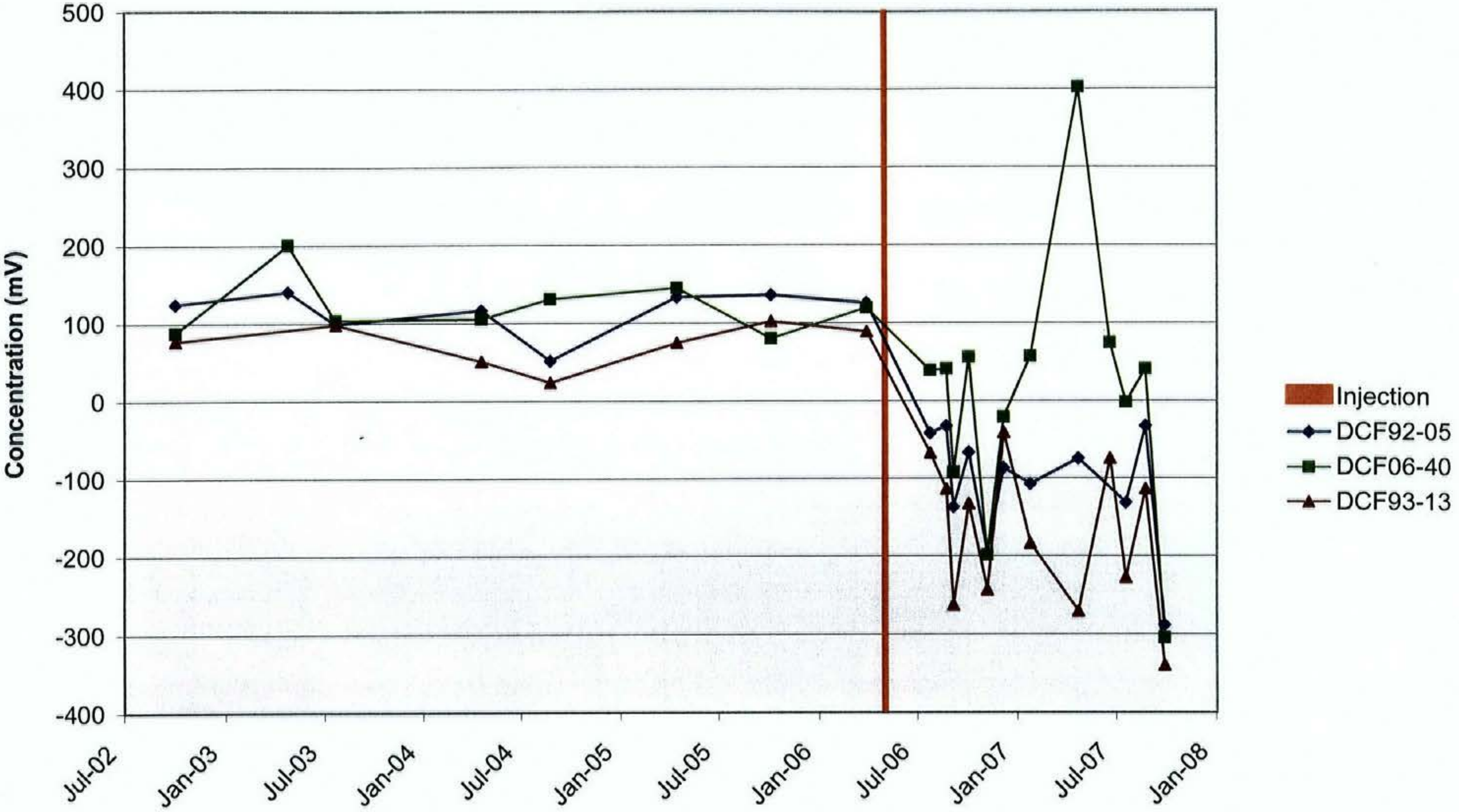
Burns & McDonnell SINCE 1898

Figure 5 - 2

DO CONCENTRATIONS AOC 2

DCF Site, Fort Riley, Kansas

Tables section5.xls

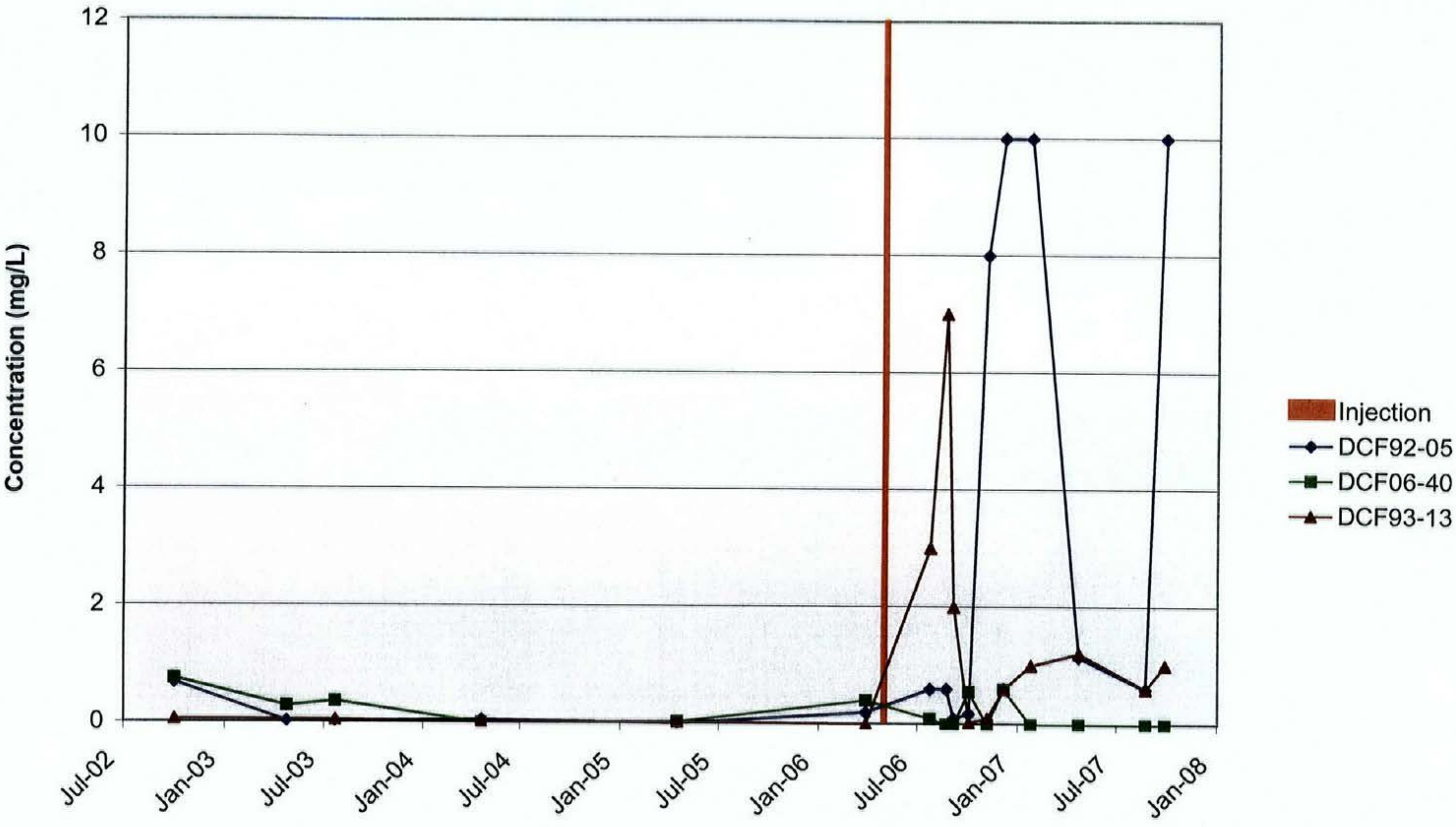


Burns & McDonnell SINCE 1898

Figure 5 - 3

ORP CONCENTRATIONS
AOC 2

DCF Site, Fort Riley, Kansas



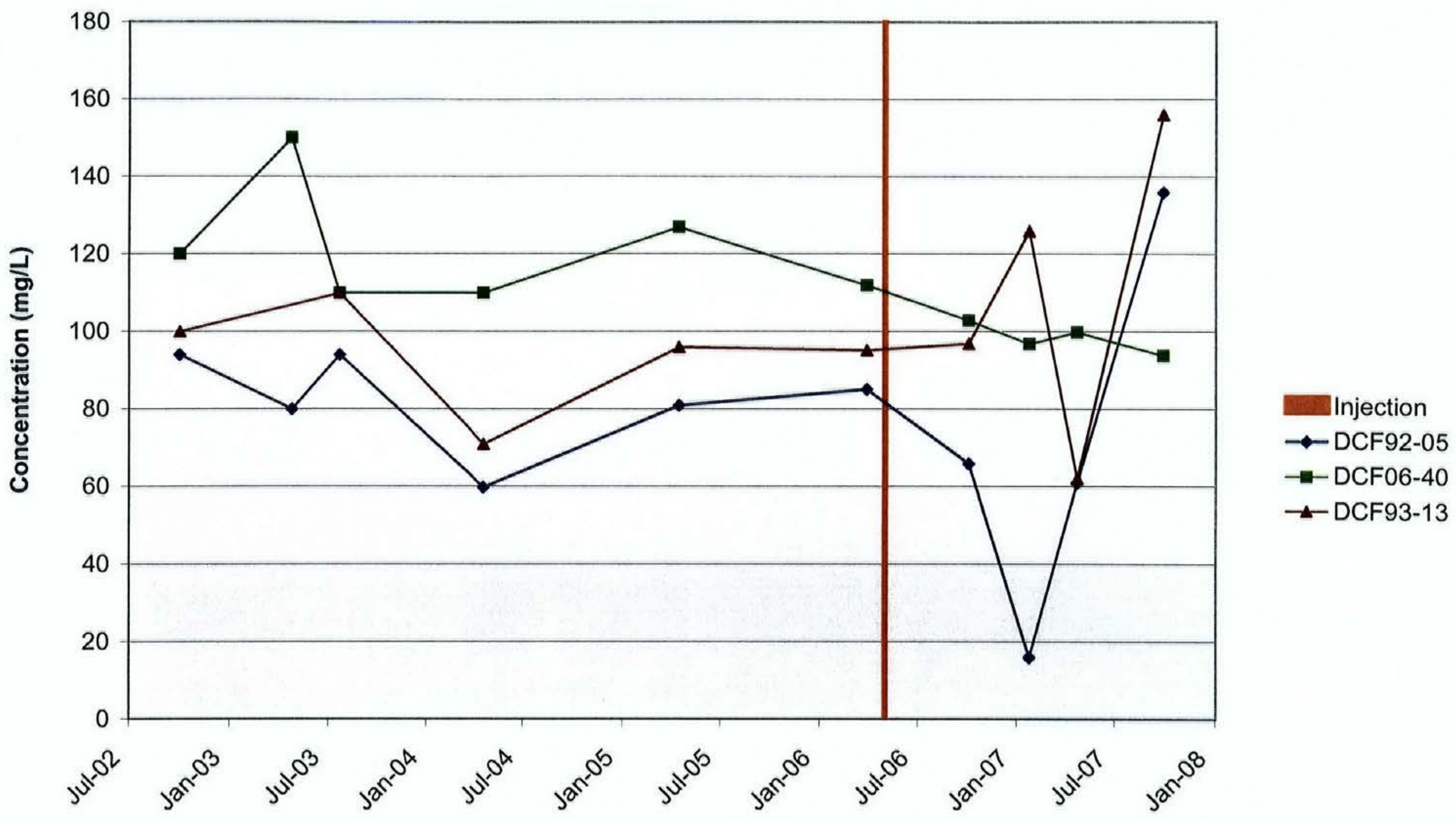
Burns & McDonnell SINCE 1898

Figure 5 - 4

FERROUS IRON CONCENTRATIONS AOC 2

DCF Site, Fort Riley, Kansas

Tables section5.xls



Burns & McDonnell SINCE 1898

Figure 5 - 5

SULFATE CONCENTRATIONS AOC 2

DCF Site, Fort Riley, Kansas

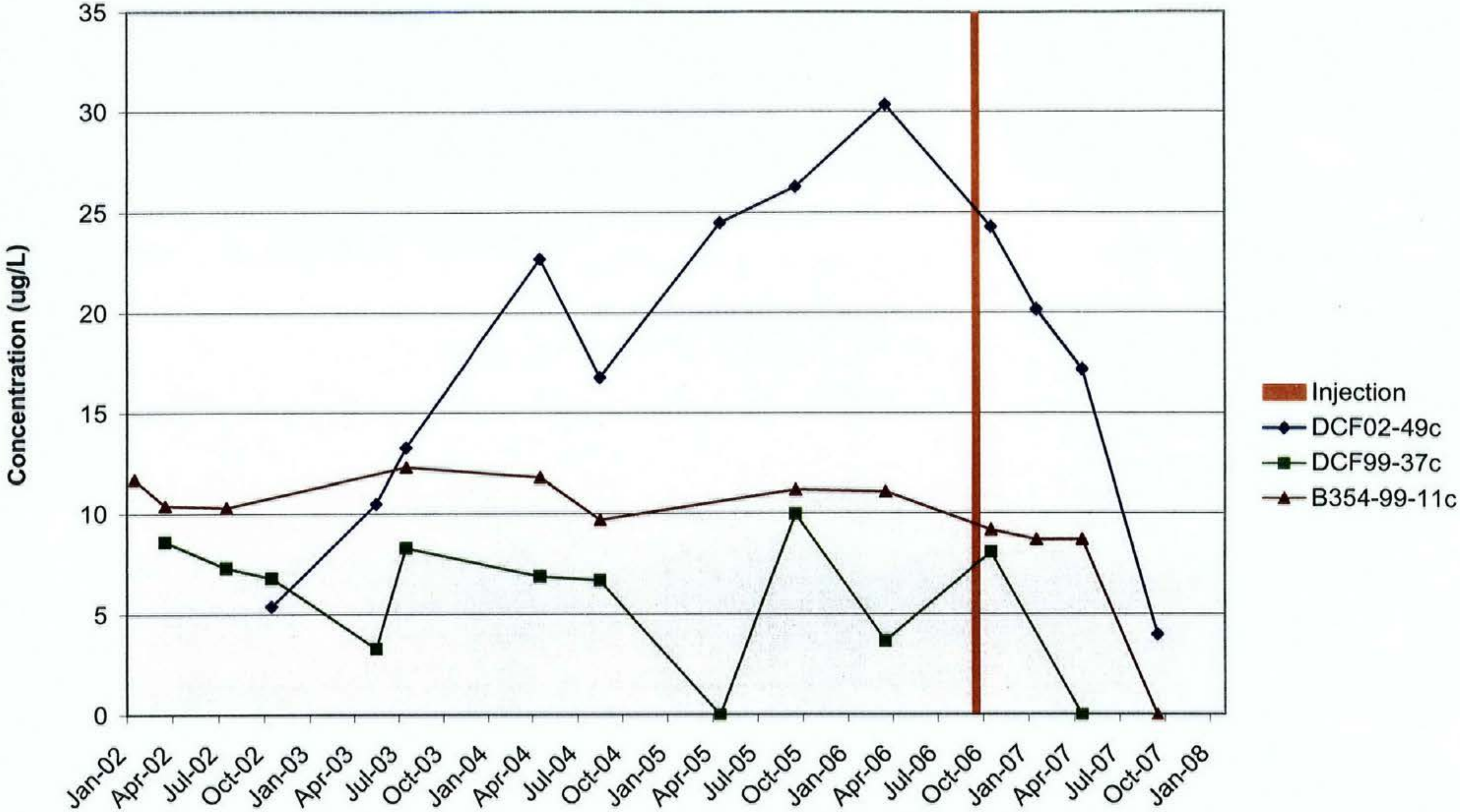
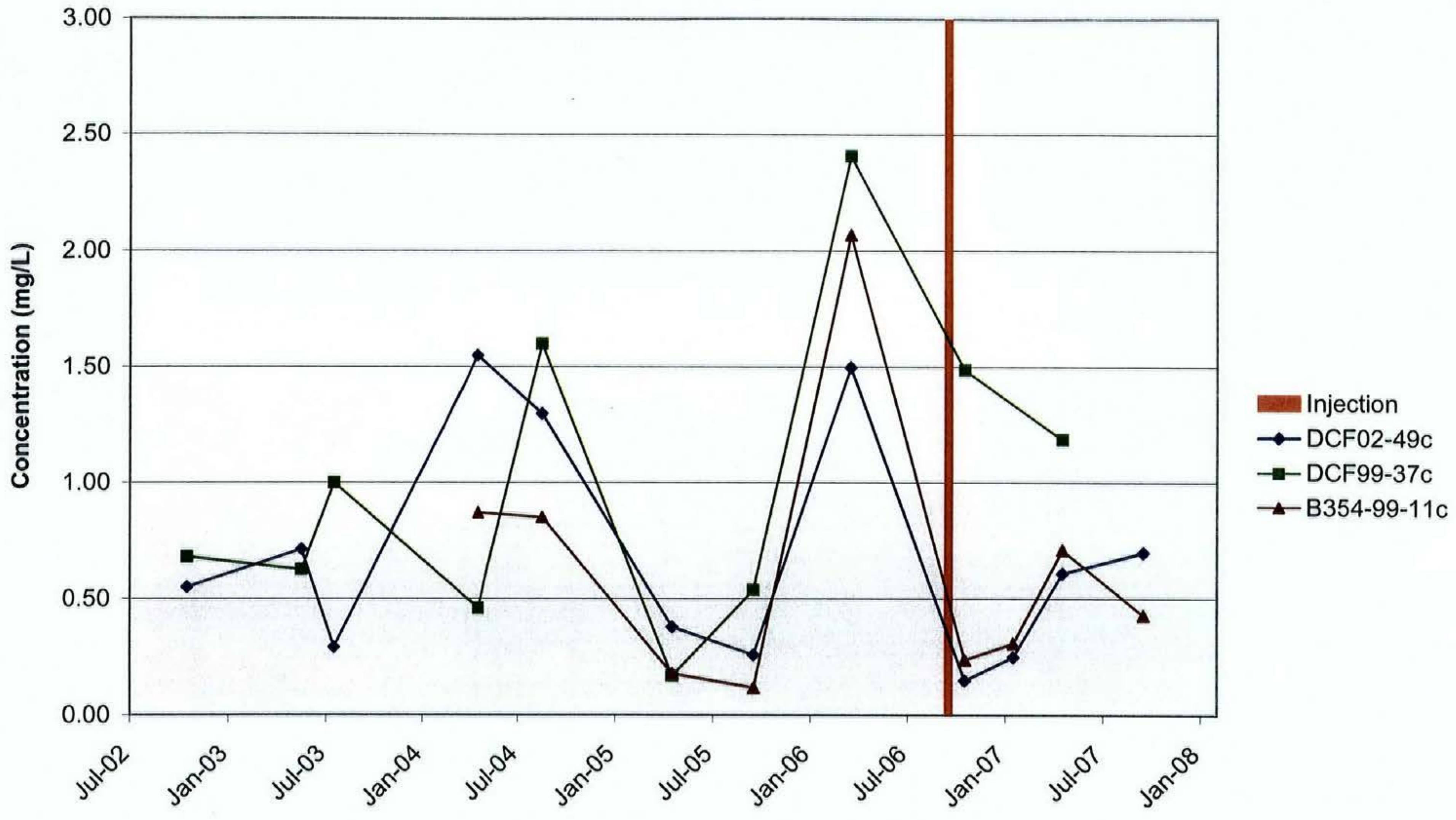


Figure 5 - 6

PCE CONCENTRATIONS OTHER AREAS

DCF Site, Fort Riley, Kansas

Burns & McDonnell SINCE 1898

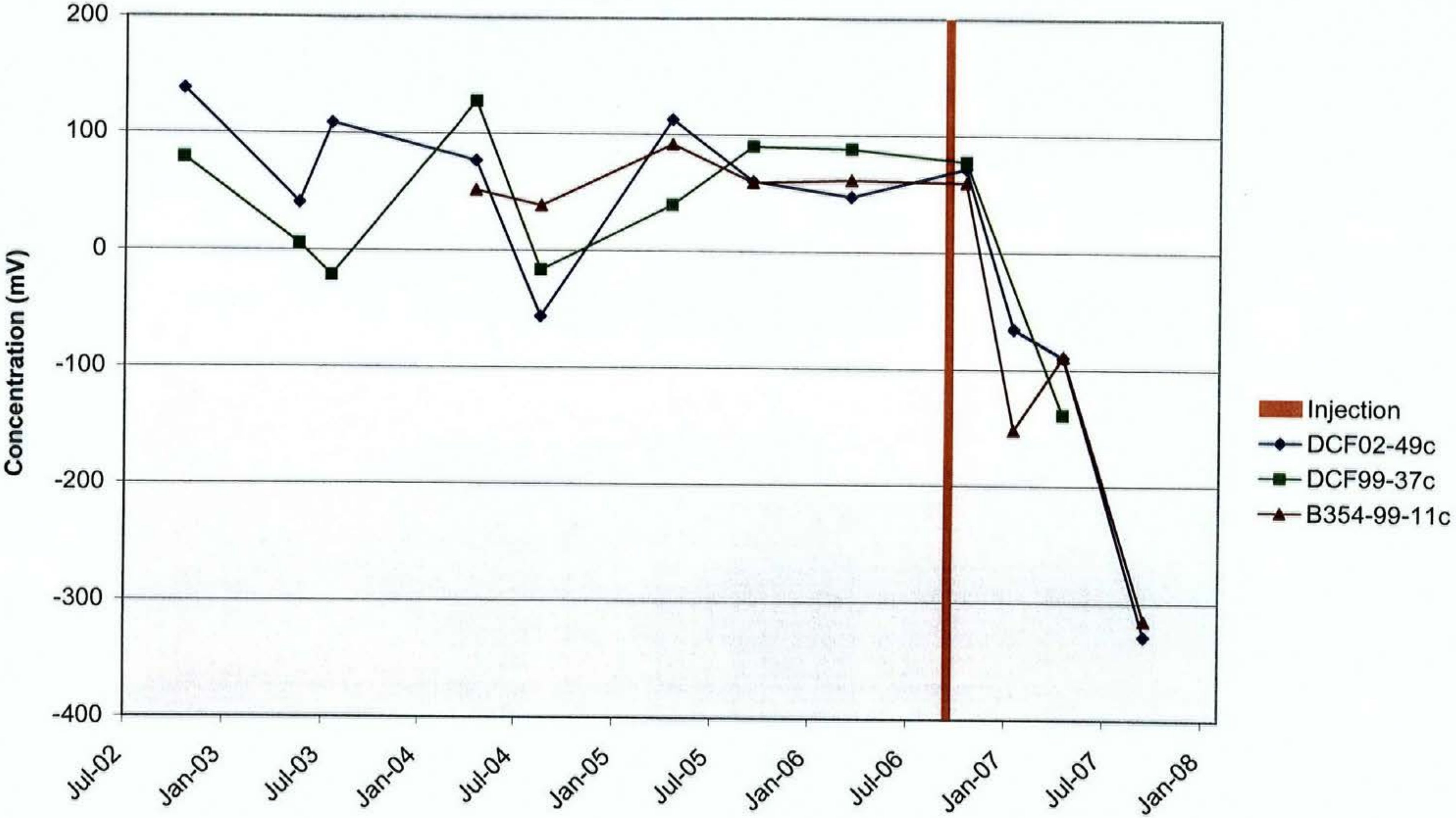


Burns & McDonnell SINCE 1898

Figure 5 - 7

DO CONCENTRATIONS OTHER AREAS

DCF Site, Fort Riley, Kansas



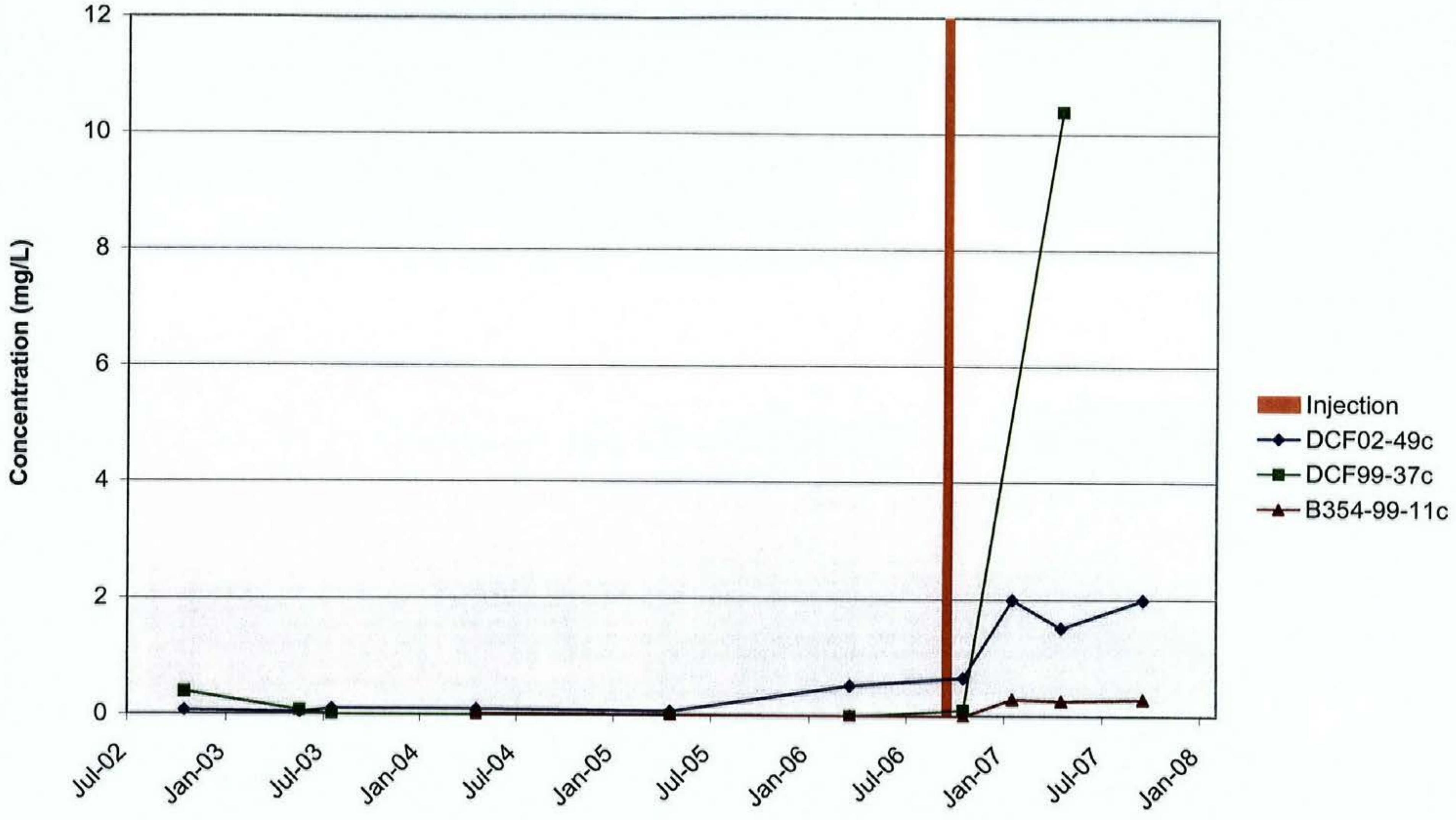
Burns & McDonnell SINCE 1898

Figure 5 - 8

ORP CONCENTRATIONS OTHER AREAS

DCF Site, Fort Riley, Kansas

Tables section5.xls



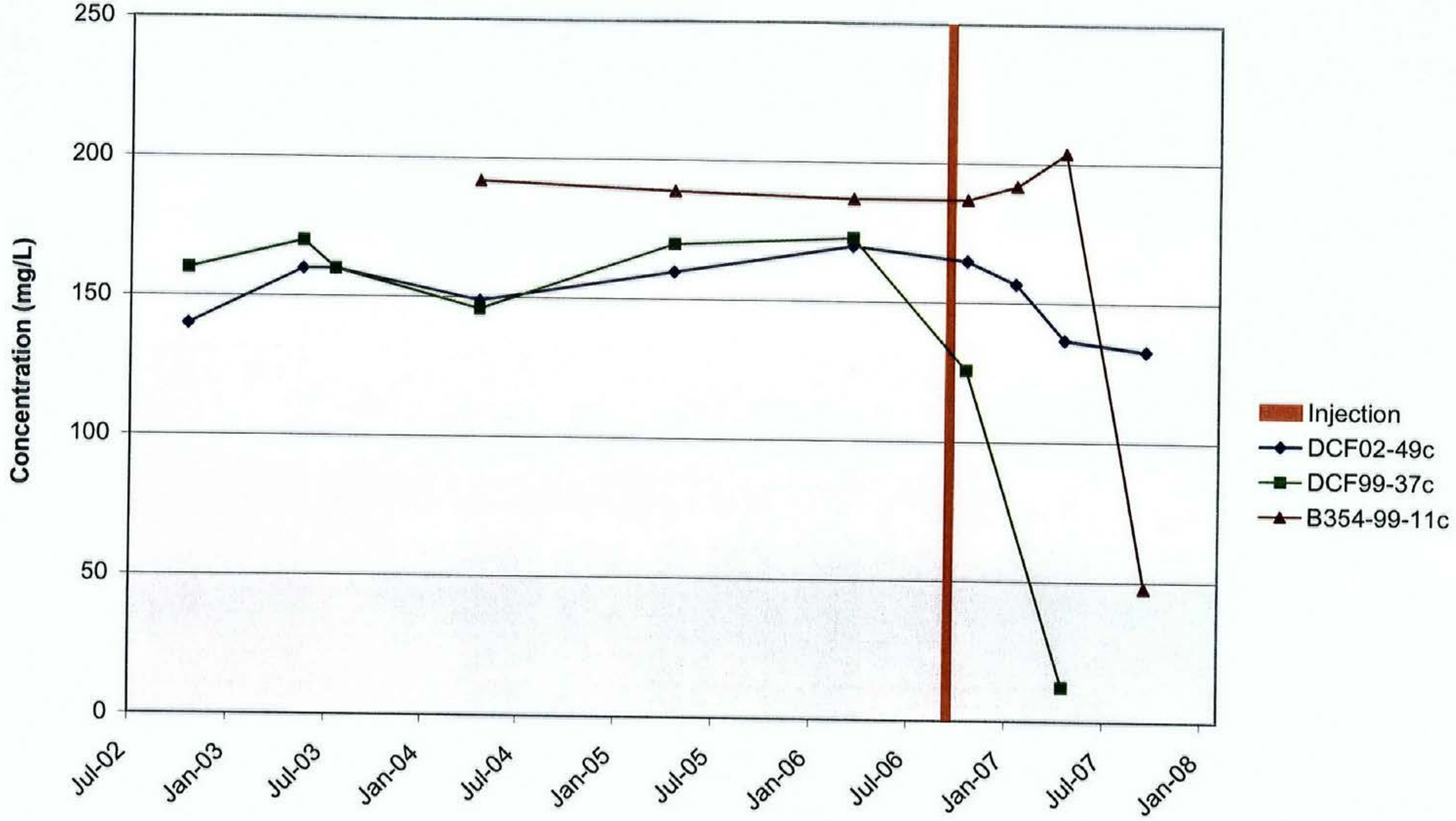
Burns & McDonnell SINCE 1898

Figure 5 - 9

FERROUS IRON CONCENTRATIONS OTHER AREAS

DCF Site, Fort Riley, Kansas

Tables section5.xls



Burns & McDonnell SINCE 1898

Figure 5 - 10

SULFATE CONCENTRATIONS OTHER AREAS

DCF Site, Fort Riley, Kansas

Appendix A
Class V Injection Permit

Burns & McDonnell
SINCE 1898

November 1, 2005

Mr. Kirk Hoeffner
Bureau of Water
1000 SW Jackson Street, Suite 420
Topeka, Kansas 66612-1367

Dry Cleaning Facility Area (DCFA) Remediation Project
Fort Riley, Kansas

Dear Mr. Hoeffner

Enclosed is a summary of the information requested for the remediation project at the DCFA in Fort Riley, Kansas. The injection portion of the project is scheduled for the middle portion of November through December 2005. If you have any questions or need additional information, please call me at 816-822-4357.

Sincerely,

Walter B. McClendon

9400 Ward Parkway
Kansas City, Missouri 64114-3319
Tel: 816 333-9400
Fax: 816 333-3690
www.burnsmcd.com

Reply to:.(785) 296-5560 FAX (785) 296-5509
Bureau of Water - Geology Section
1000 S. W. Jackson Street, Suite 420
Topeka, Kansas 66612-1367

KANSAS DEPARTMENT OF HEALTH & ENVIRONMENT

Information that must be submitted in support of a proposal to inject remedial compounds into a Class V Underground Injection Control Well (Injection Point) for remediation projects:

1. Name of facility and facility owner.

2. Name, address and telephone number of facility owner.

3. Site legal description of the injection points, injection point identification numbers and a facility map with the location of the injection points depicted in relation to water supply wells and monitoring wells located at and near the facility.

4. Documentation KDHE's Bureau of Environmental Remediation approves the injection of the remedial compounds for the remediation project.

5. A description of the contamination and contamination source.

6. Schematic of typical injection point design.

7. Name and description of the geological formation into which the remedial compound will be injected.

8. Approximate depth below groundsurface of injection interval.

9. Detailed description of the injection procedure, including proposed injection pressure.

10. Description of the contents and characteristics of the remedial compounds to be injected.

11. The amount of remedial compound to be injected.

12. Frequency of injection.

13. Plugging procedure for the injection point including a schematic of the injection point after plugging.

14. Description of the basic chemistry of the remediation process, including products and by-products.

db
05/03

Kansas Department of Health and Environment

1). Name of facility and facility owner.
Dry Cleaning Facilities Area (DCFA)
Fort Riley, U.S. Department of Defense

2). Name, address, and telephone number of facility owner.
Conservation and Restoration Branch
Department of Public Works
Attention: John Shimp (785) 239-3343
Building 407 Main Post
Fort Riley, Kansas 66442-6016

3). Site legal description of the injection points, injection point identification numbers, and a facility map with the location of the injection points depicted in relation to water supply wells and monitoring wells located at and near the facility.
The DCFA is located within the Fort Riley Military Reservation in north central Kansas. Since the treatment areas are within the military reservation, there are no township, range, or section designations. Figure 1 shows the site in relationship to the monitoring wells, the municipal supply wells, and the injection points. There are three areas of injections, two north of the Union Pacific Railroad (UPRR) tracks and one south of the UPRR tracks. For the western area north of the tracks, a chemical oxidant will be applied to 25 locations in the subsurface within a twenty foot grid. The eastern area north of the tracks will contain 70 locations on 18-ft centers. The area south of the UPRR will contain 63 locations 10-ft centers.

4). Documentation KDHE's Bureau of Environmental Remediation approves the injection of the remedial compounds for the remediation project.
See attached letter of approval from Jim Anstaett (Project Manager) and Rob Weber (Unit Manager) of KDHE BER.

5). A description of the contamination and contamination source.
Contaminants of concern are tetrachloroethylene (PCE) and the degradation products trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), and vinyl chloride. Please see Figure 2.

6). Schematic of typical injection point design.
See attached Figure 3.

7). Name and description of geological formation into which the remedial compound will be injected.
The areas of remedial injection include unconsolidated deposits in an alluvial terrace (western area north of the UPRR) and a bedrock erosional channel (eastern area north of the UPRR); and Kansas River Alluvium (area south of the UPRR). The geology of

the alluvial terrace consists of clays, sands, and silts overlying Permian age sedimentary rock composed of alternating sequences of shale and limestone. Depth to bedrock is approximately 31 feet below ground surface (bgs). The bedrock erosional channel underlies the eastern portion of the site. The axis of the channel runs northeast/southwest and extends south of the UPRR. Sand is present within the bedrock erosional channel along with interbedding silts and clays overlying Permian age sedimentary rock. Depth to bedrock is approximately 40 feet bgs. Subsurface soils south of the UPRR are composed primarily of alluvial sediment deposited by the Kansas River. Subsurface lithologies in these areas represent an upward-fining sequence typical of alluvial point bar and floodplain sediments. Depth to bedrock varies from 28 feet bgs to 50 feet bgs.

8). Approximate depth below groundwater of injection intervals.

For the western area north of the UPRR tracks, injections will occur in the vadose zone above the water table between 5 and 30 feet bgs. For the bedrock erosional channel located in the eastern part of the site north of the UPRR, the treatment interval will occur between 35 and 45 feet bgs. For the area south of the UPRR, the treatment interval intends from 30 to 40 feet bgs.

9). Detailed description of the injection procedure, including proposed injection pressure for each area.

Western Injection Area

For the vadose zone injection in the western area north of the UPRR (see Figure 4), the sodium permanganate ($NaMnO_4$) oxidant solution will be injected into the vadose zone at each injection location through direct push rods using an injection pump, delivery hose, and mobile injection trailer. The mobile injection trailer is equipped with the mixing tanks, transfer pumps, valves, piping, and instrumentation necessary for chemical mixing and delivery. The 10% $NaMnO_4$ solution will be created in the mixing tanks by combining 40% $NaMnO_4$, obtained from a manufacturer, with the necessary volume of water. A water truck will be used as the water source. The oxidant solution will be fed by gravity to the injection pump. The injection pump will be connected to direct-push rods using a high-pressure hose and the rods will be equipped with an injection probe tip. The oxidant will be injected at approximately 100 pounds per square inch (psi). For shallow application depths (5 ft bgs), the injection pressure may be lowered to avoid short circuiting.

Oxidant injection at each location will be accomplished using either a "top-down" or "bottom-up" direct-push injection method. For the "top-down" method, the direct-push rods will initially be advanced to approximately 5 foot bgs. A predetermined volume of oxidant solution will then be injected using the injection pump. After injecting the desired volume, the direct-push rods will be advanced an additional 3 to 5 feet and injection will resume. The process will be repeated until the direct-push rods are advanced to a maximum depth of approximately 25 to 30 feet bgs. The "top-down" injection methodology is preferable because this method would reduce short circuiting to the surface through an open borehole.

For the "bottom-up" method, the direct push rods will initially be advanced to approximately 25 to 30 feet bgs. A predetermined volume of oxidant solution will then be injected using the injection pump. After injecting the desired volume, the direct-push rods will be retracted, using an injection pull cap, approximately 2 to 5 feet and injection will resume. The process will be repeated until the direct-push rods are retracted to a minimum depth of approximately 5 feet bgs. The "bottom down" application methodology will be used only after the "top down" application methodology has failed. Failure of the "top down" application methodology is usually attributed to plugged injection slots or formation permeability.

For each application methodology, approximately 460 gallons of oxidant solution will be injected at each location. A totalizing flow meter will be used to monitor the oxidant flow rate and cumulative volume injected.

Eastern Injection Area
For the bedrock erosional trench located in the eastern area of the site north of the UPRR, injection will be accomplished at each injection location through direct push rods using an injection pump and delivery hose (see Figure 5). CAP18™ will be fed by gravity to the injection pump. The injection pump will be connected to direct-push rods using a high-pressure hose and the rods will be equipped with an injection probe tip. Injection at each location will be accomplished using either a "top-down" or "bottom-up" direct-push injection method. For either method, the injection will be conducted in approximately 3 foot intervals, thus the target charge is approximately 60 pounds per injection interval (180 pounds per injection point) at approximately 100 psi.

CAP18™ will be applied in an 85-foot by 240-foot area, incorporating the area that extends southwesterly from MH 363 to former Building 180 (See Figure 1-5). The treatment interval extends from the water table (approximately 35 feet bgs) to the bedrock surface (approximately 45 feet bgs) and varies in thickness from approximately 3 to 10 feet. The soil type in this interval consists of sand with minor amounts of clay. CAP18™ will be applied through direct-push rods at 70 locations, spaced evenly (18 feet center-to-center) throughout the injection area.

Southern Area
For the injection area south of the UPRR located in the Kansas River Alluvium, a high-pressure jetting technique is the preferred method of potassium permanganate ($KMnO_4$) emplacement based on the high radial injection coverage. Low pressure injection will be used in the event that high-pressure jetting becomes unfeasible due to low or partial radial injection coverage. The high-pressure jetting technique will emplace the oxidant slurry through direct-push rods at approximately 63 locations, spaced throughout the injection area (see Figure 6). Approximately 500 pounds of $KMnO_4$ will be emplaced at each location.

The high-pressure jetting method of $KMnO_4$ emplacement will employ a series of jets, directed horizontally, positioned 90 degrees from each other, and evenly spaced along the vertical axis of the jetting lance. Prior to jetting, a two to three inch diameter casing will be advanced to the base of the targeted interval using direct-push or drilling techniques. Following installation of the casing, the lance will be lowered to the base of the casing and the casing will be retracted to expose the jets to the formation. High-pressure jetting will then begin by injecting a slurry, composed of water, bentonite, and $KMnO_4$, at pressures up to 10,000 psi; mixing the oxidant slurry and sand formation until approximately 500 pounds of $KMnO_4$ have been emplaced. Approximately 200 to 300 gallons of water will be used at each location to emplace the oxidant. A water tank will be used as the water source. The jetting process is expected to produce a disc-shaped distribution (radial) composed of a $KMnO_4$/sand mixture with a radius of approximately 5 to 10 ft. The characteristics and exact dimensions of each injection distribution will vary.

If the low-pressure injection technique is used, the technique will emplace the oxidant slurry through direct-push rods at approximately 104 locations, spaced throughout the injection area. Approximately 300 pounds of $KMnO_4$ will be injected at each location. The low-pressure injection method of $KMnO_4$ emplacement will use a pump to inject the water/bentonite/ $KMnO_4$ slurry into the saturated zone at each location. Prior to injection, direct-push rods will be advanced to the targeted depth. Following installation of the direct-push rods, the oxidant slurry will be injected into the formation until approximately 300 pounds of $KMnO_4$ have been emplaced at each location. Approximately 100 gallons of water will be used at each location to emplace the oxidant. A water tank will be used as the water source. The injection process is expected to produce a bulb-shaped $KMnO_4$ distribution with a radius of approximately 3 to 5 ft. The characteristics and exact dimensions of each injection distribution will vary.

10). Description of the contents and characteristics of the remedial compounds to be injected,

For the areas west and north of the UPRR, the injected oxidant will consist of $NaMnO_4$ and $KMnO_4$, respectively. Permanganate is commercially available as two salts, either potassium or sodium, which differ primarily in solubility. The active oxidant is the permanganate ion; the cation (potassium or sodium) associated with the permanganate does not affect the oxidation potential of the permanganate ion, thus the selection of which salt to use depends upon evaluation of site factors and design considerations. A treatability bench study will be conducted to determine the natural oxidant demand (NOD) of the soil. Natural organic matter (NOM) and reduced metal species in the subsurface can exert a significant oxidant demand that competes with the chemicals of concern (COC) for the available permanganate, and may directly affect permanganate's persistence and transport in the subsurface and lead to incomplete chemical oxidation of the target compound(s). The results from the NOD treatability bench study are used to determine the mass of permanganate required for complete in-situ chemical oxidation. At most sites, the NOD of the soil is several orders of magnitude greater than the demand expressed by the COC. The mass of permanganate required to satisfy the contaminant demand is determined based on an assessment of the contaminant mass, phase, and distribution as well as the permanganate/contaminant stoichiometric relationships.

The evaluation of permanganate consumption will be conducted by monitoring the decay of MnO_4, thus allowing for a direct determination of the NOD on a mass/mass basis [gram (g) MnO_4^-/g soil]. This will determine the approximate volume of permanganate required in order to treat the COCs, as well as overcome the NOD presented by the native soils. The by-products of oxidation of permanganate and chlorinated VOCs include carbon dioxide, potassium, hydrogen, chloride, and insoluble manganese dioxide.

For the bedrock erosional channel, enhanced anaerobic bioremediation (EAB) will be used. EAB consists of injecting a carbon source into the aquifer to promote anaerobic bioremediation. Carbon sources such as vegetable oil can be added to aquifer materials to enhance and stimulate the natural degradation process. When applied to the target area, the vegetable oil can provide a constant carbon source for the anaerobic degrading microbes. For injection in this area, CAP-18™, a vegetable oil product manufactured by Seabreeze, LLC will be utilized. CAP-18™ is a vegetable oil product composed of triacylglycerols that breakdown into acetic acid and hydrogen gas. The resulting hydrogen can be used by reductive dehalogenators that are capable of dechlorinating PCE and associated chlorinated solvents. One of the benefits of the vegetable oil technology is the partitioning of the contaminants in the oil rather than on the subsurface structure or groundwater, thus reducing the amount of dissolved contaminant and the risk to downgradient receptors.

For all three oxidant products, see attached material safety data sheets (MSDS).

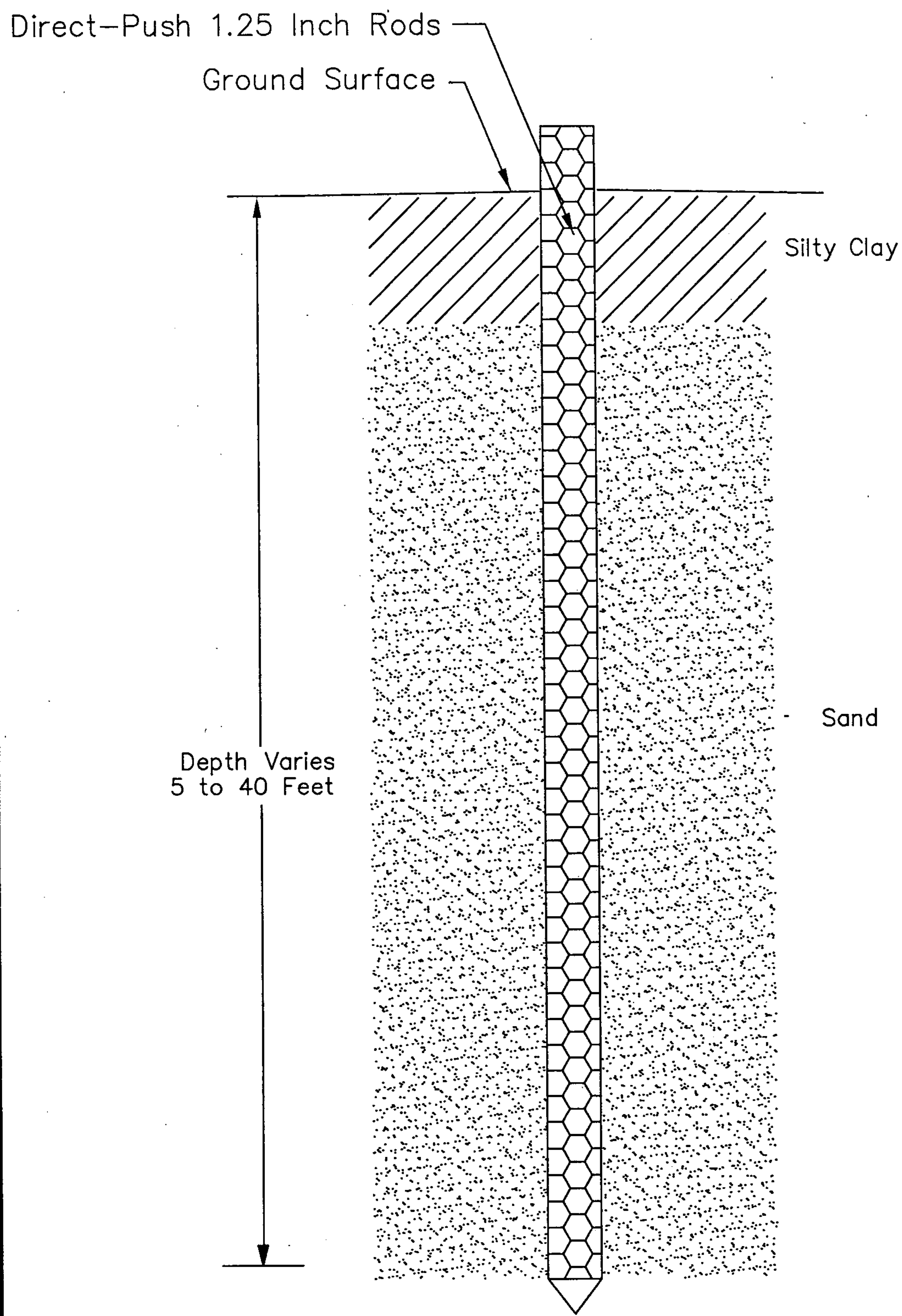
11). The amount of remedial compound to be injected for each area.
For the western area north of the UPRR, approximately 2,940 pounds of $NaMnO_4$ will be injected through 25 locations. For the bedrock erosional channel, approximately 8,000 pounds of CAP-18™ will be injected through 70 injection points. For the area south of the UPRR, approximately 31,200 pounds of $KMnO_4$ through 63 locations.

12). Frequency of injection
Injections at these locations will be one time only.

13). Plugging procedure for the injection point including a schematic of the injection point after plugging.
Standard industry procedures (i.e. backfill with bentonite)

14). Description of the basic chemistry of the remediation process, including products and byproducts.
Cap-18™ (vegetable oil) consists of triacylglycerols, which are composed of long-chain fatty acids and glycerol. The fatty acids, which consist of large hydrogen-rich molecules, are digested by microorganisms via beta oxidation. A series of beta

oxidation cycles reduces the fatty acids to produce molecules of acetic acid and hydrogen gas. For permanganate, (typically provided as either sodium or potassium salts) can destroy contaminants by either direct electron transfer or free radical advanced oxidation. Permanganate treatment is effective over a pH ranging from acidic to alkaline (3.5 to 12). Permanganate is a selective oxidant in that it has the potential to be less reactive with some of the natural organics and can persist longer in the subsurface than other oxidants such as Fenton's reagent or ozone. Permanganate is generally effective in treating chlorinated ethenes (i.e., PCE, TCE, and cis-1,2-DCE). The by-products of oxidation of permanganate and chlorinated VOCs include carbon dioxide, potassium, hydrogen, chloride, and insoluble manganese dioxide.



NOTE: Bentonite hydrated in one foot lifts.

LEGEND:

Bentonite Pellets

NOT TO SCALE

Burns & McDonnell
SINCE 1898

Figure 7
Typical Abandoned
Direct-Push
Construction Diagram
DCFA
Fort Riley, Kansas

k:\env\USACE\Site\27979\Deliver\Pilot Study Field Work\UIC Permit\dp.dwg 05/05/05

KANSAS

RODERICK L. BREMBY, SECRETARY

KATHLEEN SEBELIUS, GOVERNOR

DEPARTMENT OF HEALTH AND ENVIRONMENT

July 13, 2005

Directorate of Environment and Safety
AFZN-ES-OM (Mr. Craig Phillips)
407 Pershing Court
Ft. Riley, Kansas 66442

Subject: **Draft Work Plan Pilot Study for Soil and Groundwater Remediation for the Dry Cleaning Facilities Area (Operable Unit 003) Fort Riley, Kansas, June 2005**

Dear Mr. Phillips:

The Kansas Department of Health and Environment (KDHE/BER) received the above referenced document on June28, 2005. KDHE/BER approves of the document.

Should you have any questions, please contact me at (785) 291-3249.

Sincerely,

Jim Anstaett
Geology Associate and Project Manager
Superfund Unit/Assessment and Restoration Section

Robert J. Weber, PG
Professional Geologist & Unit Manager
Superfund Unit/Assessment and Restoration Section

JA:at

cc: Rob Weber→Leo Henning→files C5-031-03035-1 (Fort Riley – DCFA)
Scott Lang, KDHE NCDO
Robin Paul, EPA Region VII
John Shimp, Ft. Riley
Richard Van Saun, USACE

MSDS Number: **P6005** * * * * * *Effective Date: 11/02/01* * * * * * *Supercedes: 11/17/99*

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

POTASSIUM PERMANGANATE

1. Product Identification

Synonyms: Permanganic acid, potassium salt; Condy's crystals
CAS No.: 7722-64-7
Molecular Weight: 158.03
Chemical Formula: $KMnO_4$
Product Codes:
J.T. Baker: 3227, 3228, 3232
Mallinckrodt: 7056, 7068

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Permanganate	7722-64-7	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. CAUSES BURNS TO ANY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Inhalation:
Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. High concentrations can cause pulmonary edema.
Ingestion:
Ingestion of solid or high concentrations causes severe distress of gastro-intestinal system with possible burns and edema; slow pulse; shock with fall of blood pressure. May be fatal. Ingestion of concentrations up to 1% causes burning of the throat, nausea, vomiting, and abdominal pain; 2-3% causes anemia and swelling of the throat with possible suffocation; 4-5% may cause kidney damage.
Skin Contact:
Dry crystals and concentrated solutions are caustic causing redness, pain, severe burns, brown stains in the contact area and possible hardening of outer skin layer. Diluted solutions are only mildly irritating to the skin.
Eye Contact:
Eye contact with crystals (dusts) and concentrated solutions causes severe irritation, redness, blurred vision and can cause severe damage, possibly permanent.
Chronic Exposure:
Prolonged skin contact may cause irritation, defatting, and dermatitis. Chronic manganese poisoning can result from excessive inhalation exposure to manganese dust and involves impairment of the central nervous system. Early symptoms include sluggishness, sleepiness, and weakness in the legs. Advanced cases have shown symptoms of fixed facial expression, emotional disturbances, spastic gait, and falling.
Aggravation of Pre-existing Conditions:
No information found.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Contact with oxidizable substances may cause extremely violent combustion.
Explosion:
Strong oxidants may explode when shocked, or if exposed to heat, flame, or friction. Also may act as initiation source for dust or vapor explosions. Contact with oxidizable substances may cause extremely violent combustion. Sealed containers may rupture when heated. Sensitive to mechanical impact.
Fire Extinguishing Media:
Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Suffocating type extinguishers are not as effective as water. Do not allow water runoff to enter sewers or waterways.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage and moisture. Isolate from any source of heat or ignition. Avoid storage on wood floors. Separate from incompatibles, combustibles, organic or other readily oxidizable materials. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
5 mg/m3 Ceiling for manganese compounds as Mn

- ACGIH Threshold Limit Value (TLV):
0.2 mg/m3 (TWA) for manganese, elemental and inorganic compounds as Mn

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Purple-bronze crystals.

Odor:
Odorless.

Solubility:
7 g in 100 g of water.
Density:
2.7
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
Not applicable.
Melting Point:
ca. 240C (ca. 464F)
Vapor Density (Air=1):
5.40
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Toxic metal fumes may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Powdered metals, alcohol, arsenites, bromides, iodides, phosphorous, sulfuric acid, organic compounds, sulfur, activated carbon, hydrides, strong hydrogen peroxide, ferrous or mercurous salts, hypophosphites, hyposulfites, sulfites, peroxides, and oxalates.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

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11. Toxicological Information

Investigated as a mutagen, reproductive effector. Oral rat LD50: 1090 mg/kg.

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--------\Cancer Lists\------------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC Category
------------------------------------    -----    -----------    -------------
Potassium Permanganate (7722-64-7)       No          No             None
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12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
This material may be toxic to aquatic life.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: RQ, POTASSIUM PERMANGANATE
Hazard Class: 5.1
UN/NA: UN1490
Packing Group: II
Information reported for product/size: 110LB

International (Water, I.M.O.)

Proper Shipping Name: POTASSIUM PERMANGANATE
Hazard Class: 5.1
UN/NA: UN1490
Packing Group: II
Information reported for product/size: 110LB

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15. Regulatory Information

```
--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                      TSCA  EC   Japan  Australia
----------------------------------------------- ----  ---  -----  ---------
Potassium Permanganate (7722-64-7)               Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\---------------------------------
                                                        --Canada--
Ingredient                                      Korea  DSL   NDSL  Phil.
```

Potassium Permanganate (7722-64-7)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Potassium Permanganate (7722-64-7)	No	No	No	Manganese co

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Potassium Permanganate (7722-64-7)	100	No	No

```
Chemical Weapons Convention:  No     TSCA 12(b):  No      CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: 2Y
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. CAUSES BURNS TO ANY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED.
Label Precautions:
Keep from contact with clothing and other combustible materials.
Store in a tightly closed container.
Do not store near combustible materials.
Remove and wash contaminated clothing promptly.
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In all cases get medical attention immediately.
Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

****

Prepared by: Environmental Health & Safety

Phone Number: (314) 654-1600 (U.S.A.)

Cargill

Dressings, Sauces, and Oils North America
Material Safety Data Sheet

Date Issued: 06/01/1995
Date Revised: 11/3/1999
Date Reviewed: 1/6/2003

CARGILL PRODUCT: 100CAP18 **CUSTOMER CODE:** CAP18

CUSTOMER: DBI Remediation Products

DESCRIPTION: Vegetable Oil Product

TRADE NAME/SYNONYMS: Liquid Vegetable Oil

CHEMICAL FAMILY: Glyceride Oils

CAS NO.: 006896-68-3

HMIS CODE: H F R P
0 1 0 A

SECTION I - MANUFACTURING IDENTIFICATION

MANUFACTURER'S NAME: Cargill, Incorporated
ADDRESS: Refined Oils, P. O. Box 5396
Minneapolis, Minnesota 55440

24 HOUR EMERGENCY ASSISTANCE: Chemtrec: (800) 424-9300

GENERAL MSDS ASSISTANCE: (770) 531-4788

SECTION II - HAZARDOUS INGREDIENTS / IDENTITY INFORMATION

Is not hazardous under the Department of Labor definitions. Is Generally Recognized as Safe (GRAS) under the Food, Drug and Cosmetic Act.

SECTION III - PHYSICAL / CHEMICAL CHARACTERISTICS

Boiling Range: Not applicable

Specific Gravity (H20 = 1): .920-.925

Percent Volatile by Volume: 0%

Evaporation Rate: Not applicable

Vapor Density: Exceeds 1.0

Vapor Pressure: Not applicable

Solubility in Water: Insoluble

Weight/Gallon: 7.71 lbs. at 60 deg. F

Appearance and Odor: A pale yellow, oily liquid with only a faint odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Classification: Combustible Liquid - Class IIIB

Flash Point: Greater than 550° F

Method Used: Cleveland Open Cup

Extinguishing Media: UL listed Type 'K' fire extinguisher, UL wet chemical extinguishing system or water spray.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA (continued)

SPECIAL FIREFIGHTING PROCEDURES: The use of self-contained breathing apparatus is recommended for fire fighters. Avoid use of water as it may spread fire by dispersing oil. Use water to keep fire-exposed containers cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Rags and waste paper containing this material may heat and burn spontaneously. When material presenting a large surface area, such as rags, filter clay, etc., is saturated with liquid soybean oil, spontaneous combustion may result.

SECTION V - REACTIVITY DATA

STABILITY: Spontaneous combustion can occur. See Unusual Fire and Explosion Procedures, Section IV.

CONDITIONS TO AVOID: High surface area exposure to oxygen can result in polymerization and release of heat.

INCOMPATABILITY (MATERIALS TO AVOID): None

HAZARDOUS DECOMPOSITIONS OR BY-PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VI - HEALTH HAZARD DATA

OSHA PERMISSIBLE EXPOSURE LIMIT: As an oil mist - 15 mg/m3 and 5 mg/m3 respirable.

ACGIH THRESHHOLD LIMIT VALUE: As an oil mist – 10 mg/m3.

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE: Excessive inhalation of oil mist may affect the respiratory system. Oil mist is classified as a nuisance particulate by ACGIH.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE: Sensitive individuals may experience dermatitis after long exposure of oil on skin.

HEALTH HAZARDS (ACUTE AND CHRONIC): Acute: none observed by inhalation. Chronic: none reported.

EMERGENCY AND FIRST AID PROCEDURES FOR:
* SKIN CONTACT: May be removed from skin by washing with soap and warm water.
* INHALATION: Expose individual to fresh air source.

SECTION VII- PRECAUTIONS FOR SAFE HANDLING AND USE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Depending on quantity of spill: (a) Small spill - add solid adsorbent, shovel into disposable container and hose down area. Clean area with detergent. (b) Large spill - Squeegee or pump into holding container. Clean area with detergent.

WASTE DISPOSAL METHOD: Dispose of in accordance with local, state, and federal regulations.

SECTION VIII- CONTROL MEASURES

RESPIRATORY PROTECTION: Not normally needed.

VENTILATION: Intermittent clean air exchanges recommended, but not required.

PROTECTIVE GLOVES: Not normally needed.

EYE PROTECTION: Not normally needed.

SECTION IX- SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store away from flame and fire. AND excessive heat.

SECTION X- DISCLAIMER AND / OR COMMENTS

We recommend that containers be either professionally reconditioned for re-use by certified firms or properly disposed of by certified firms to help reduce the possibility of an accident. Disposal of containers should be in accordance with applicable federal, state and local laws and regulations. "Empty" drums should not be given to individuals.

The information in this MSDS was obtained from sources that we believe are reliable. However, the information is provided without any representation or warranty, expressed or implied, regarding its accuracy or correctness.

The conditions of handling, storage, use and disposal of the product are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

MATERIAL SAFETY DATA SHEET

LIQUOX™ Sodium Permanganate

NFPA* HAZARD SIGNAL

Health Hazard (less than 1 hour exposure)	1 =	Materials which under fire conditions would give off irritating combustion products. Materials which on the skin could cause irritation.
Flammability Hazard	0 =	Materials that will not burn.
Reactivity Hazard	0 =	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.
Special Hazard	OX =	Oxidizer

* National Fire Protection Association 704

FIRST RESPONDERS: Wear protective gloves, boots, goggles, and respirator. In case of fire, wear positive pressure breathing apparatus. Approach incident with caution. Use Emergency Response Guide NAERG 96 (RSPA P5800.7). Guide No. 140.

Section I Product Identification

MANUFACTURER'S NAME: CARUS CORPORATION

TELEPHONE NUMBER FOR INFORMATION: 815\223-1500

MANUFACTURER'S ADDRESS: Carus Chemical Company
1500 Eighth Street
P. O. Box 1500
LaSalle, IL 61301

EMERGENCY TELEPHONE NO.: 800\435-6856

CHEMTREC TELEPHONE NO.: 800\424-9300

PRODUCT NAME: LIQUOX™ Sodium Permanganate,$NaMnO_4$
TRADE NAME: LIQUOX™ Sodium Permanganate
SYNONYMS: Permanganic acid sodium salt solution

Section II Fire and Explosion Hazard Data

The material itself is noncombustible but will accelerate the burning of combustible material.

FLASHPOINT None

FLAMMABLE OR EXPLOSIVE LIMITS Lower: Nonflammable Upper: Nonflammable

EXTINGUISHING MEDIA Use large quantities of water.

SPECIAL FIREFIGHTING PROCEDURES If material involved in fire, flood with water, cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Wear self-contained breathing apparatus and full protective clothing.

UNUSUAL FIRE AND EXPLOSION HAZARDS Very powerful oxidizing material. Explosive in contact with sulfuric acid or peroxides. May react violently with finely divided and readily oxidizable substances. Will ignite wood and cloth. Increases flammability of combustible material.

Section III Health Hazard Data

ROUTES OF EXPOSURE

1. Inhalation
   Acute inhalation toxicity data are not available; however, airborne concentrations of sodium permanganate in the form of mist, or spray may cause damage to the respiratory tract.

2. Skin Contact
   Sodium permanganate solution is very irritating to the skin.

3. Eye Contact
   Sodium permanganate solution is corrosive to the eye on contact. It may cause severe burns that result in damage to the eye.

4. Ingestion
   Sodium permanganate solution, if swallowed, may cause severe burns to mucous membranes of the mouth, throat, esophagus, and stomach.

EFFECTS OF OVEREXPOSURE

1. Acute Overexposure
   Irritating to body tissue with which it comes in contact.

2. Chronic Overexposure
   No known cases of chronic manganese poisoning due to sodium permanganate or other permanganates have been reported. Prolonged exposure, usually over many years, to heavy concentrations of manganese oxides in the form of dust and fumes, may lead to chronic manganese poisoning, chiefly involving the central nervous system.

3. Carcinogenicity
   Sodium permanganate solution has not been classified as a carcinogen by OSHA, NTP, IARC.

4. Medical Conditions Generally Aggravated by Exposure
   Sodium permanganate will cause further irritation of tissue, open wounds, burns or mucous membranes.

EMERGENCY AND FIRST AID PROCEDURES

1. Eyes
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. Note to physician: Decomposition products are alkaline.

2. Skin
   Immediately wash contaminated areas with plenty of water. Remove contaminated clothing and footwear. See SECTION VIII Warning OTHER PROTECTIVE EQUIPMENT. Seek medical attention immediately if irritation develops.

3. Inhalation
   Get person out of contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.

4. Ingestion
   NEVER give anything by mouth to an unconscious or convulsing person. Give large quantities of water. If available, give several glasses of milk or lemon or orange juice. Seek medical help immediately.

Section IV Hazardous Ingredients

Material or component	CAS No.*	%	Hazard Data	
Sodium Permanganate	10101-50-5	40% min.	PEL** C****	5 mg Mn per cubic meter of air
			TLV-TWA***	0.2 mg Mn per cubic meter of air

* Chemical Abstract Service Number

** OSHA Permissible Exposure Limit, manganese compounds (expressed as Mn) 29CFR1910.1000Z.A1.

*** American Conference of Governmental Industrial Hygienists 1988/1989, for manganese dust and compounds, expressed as Mn, TLV-TWA = The time weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

**** Ceiling Exposure Limit or maximum exposure concentration not to be exceeded under any circumstances.

Section V Physical Data

BOILING POINT, 760 mm Hg	105°
VAPOR PRESSURE (mm Hg)	Not applicable
SOLUBILITY IN WATER % BY SOLUTION	Miscible in all proportions with water
SPECIFIC GRAVITY	1.36g/mL
PERCENT VOLATILE BY VOLUME	60% (as water)
MELTING POINT	Not Applicable
APPEARANCE AND ODOR	Dark purple solution, odorless

Section VI Reactivity Data

STABILITY Under normal conditions, the material is stable.

CONDITIONS TO AVOID Contact with incompatible materials or heat (135°C/275°F)

INCOMPATIBLE MATERIALS Contact with acids, peroxides, and all combustible organic or readily oxidizable materials including inorganic oxidizable materials and metal powders. With hydrochloric acid, chlorine gas is liberated.

HAZARDOUS DECOMPOSITION PRODUCTS When involved in fire, corrosive fumes or smoke may be formed.

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION Material is not known to polymerize.

Section VII Spill or Leak Procedures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
Contain spill by collecting the liquid in a pit or holding behind a dam (sand or soil). Dilute to approximately 6% with water, then reduce with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH if acid was used. Decant or filter and deposit sludge in an approved landfill. Where permitted, the sludge can be drained into sewer with large quantities of water. To clean contaminated floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations. If not, collect water and treat as above.

WASTE DISPOSAL
Sodium permanganate is considered a D001 hazardous (ignitable) waste. For disposal of sodium permanganate solutions, follow above procedure and deactivate the permanganate to insoluble manganese dioxide, and dispose of it in a permitted landfill. Contact Carus Chemical Company for additional recommendations.

Section VIII Protective Equipment to Be Used

VENTILATION REQUIREMENTS
Provide sufficient mechanical and/or local exhaust to maintain exposure below levels of overexposure.

RESPIRATORY PROTECTION
In cases where overexposure may exist, the use of NIOSH-MSHA approved dust and mist respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control dust or mist.

EYE
Face shield, goggles, or safety glasses with side shields should be worn.

GLOVES
Rubber or plastic gloves should be worn.

OTHER PROTECTIVE EQUIPMENT
Normal work clothing covering arms and legs, and rubber, or plastic apron should be worn. *Caution:* If clothing becomes contaminated, wash off immediately; spontaneous ignition may occur with cloth or paper.

WORK/HYGIENIC PRACTICES
Wash hands thoroughly with soap and water, after handling sodium permanganate and before eating or smoking.

Section IX Special Precautions and Other Comments

Protect containers from physical damage. Store in a cool, dry area in closed containers or non-combustible floors. Segregate from acids, peroxides, and all combustible, organic, or easily oxidizable materials.

DEPARTMENT OF TRANSPORTATION INFORMATION:

Proper Shipping Name: 49CFR 172.101 .... Permanganates, inorganic, aqueous solution, n.o.s. (contains sodium permanganate)

ID Number: .... UN 3214
Hazard Class: .... Oxidizer 5.1

Chemtrec Telephone Number: 800/424-9300

RCRA: Oxidizers such as sodium permanganate meet the criteria of ignitable waste

Kenneth Krogulski

Kenneth Krogulski

September 1998

CARUS

Responsible Care®
A Public Commitment

Division of Carus Corporation
315 Fifth Street
P O.Box599
Peru,IL61354
Tel(815)223-1500
Fax(815)224-6697

K A N S A S

RODERICK L. BREMBY, SECRETARY

DEPARTMENT OF HEALTH AND ENVIRONMENT

KATHLEEN SEBELIUS, GOVERNOR

November 8, 2005

Mr. Walter McClendon
9400 Ward Parkway
Kansas City, Missouri
64114-3319

RE: DCFA – Fort Riley Site
Class V UIC Authorization
Injection Points: 1 thru 25, 1 thru 70 and 1 thru 63

Dear: Mr. McClendon:

The Kansas Department of Health & Environment's Geology Section KDHE administers the Underground Injection Control (UIC) program. The UIC program has oversite of Class V injection wells and has completed its review of this injection proposal submitted under your letter dated November 2, 2005, for compliance with the Underground Injection Control (UIC) Program Requirements. We have determined the proposal complies with the UIC Program requirements. This letter serves as the UIC Program authorization for the injection points.

This proposal was only reviewed for compliance with the UIC Program requirements. BER has oversight authority for this project. You must obtain BER's approval to install and operate the injection points.

The following conditions required by the UIC Program apply:

- ❑ The injection points shall not endanger public health or the environment.
- ❑ This authorization is valid only for this proposal.
- ❑ This authorization is only for the injection of sodium permanganate in geoprobe points 1 through 25, CAP-18™ in points 1 through 70, and potassium permanganate in points 1 through 63.
- ❑ Proposed significant changes of the injection proposal must be submitted to KDHE in writing, with supportive information, and have the approval of both KDHE's Bureau of Environmental Remediation (BER) and the UIC program prior to implementation.

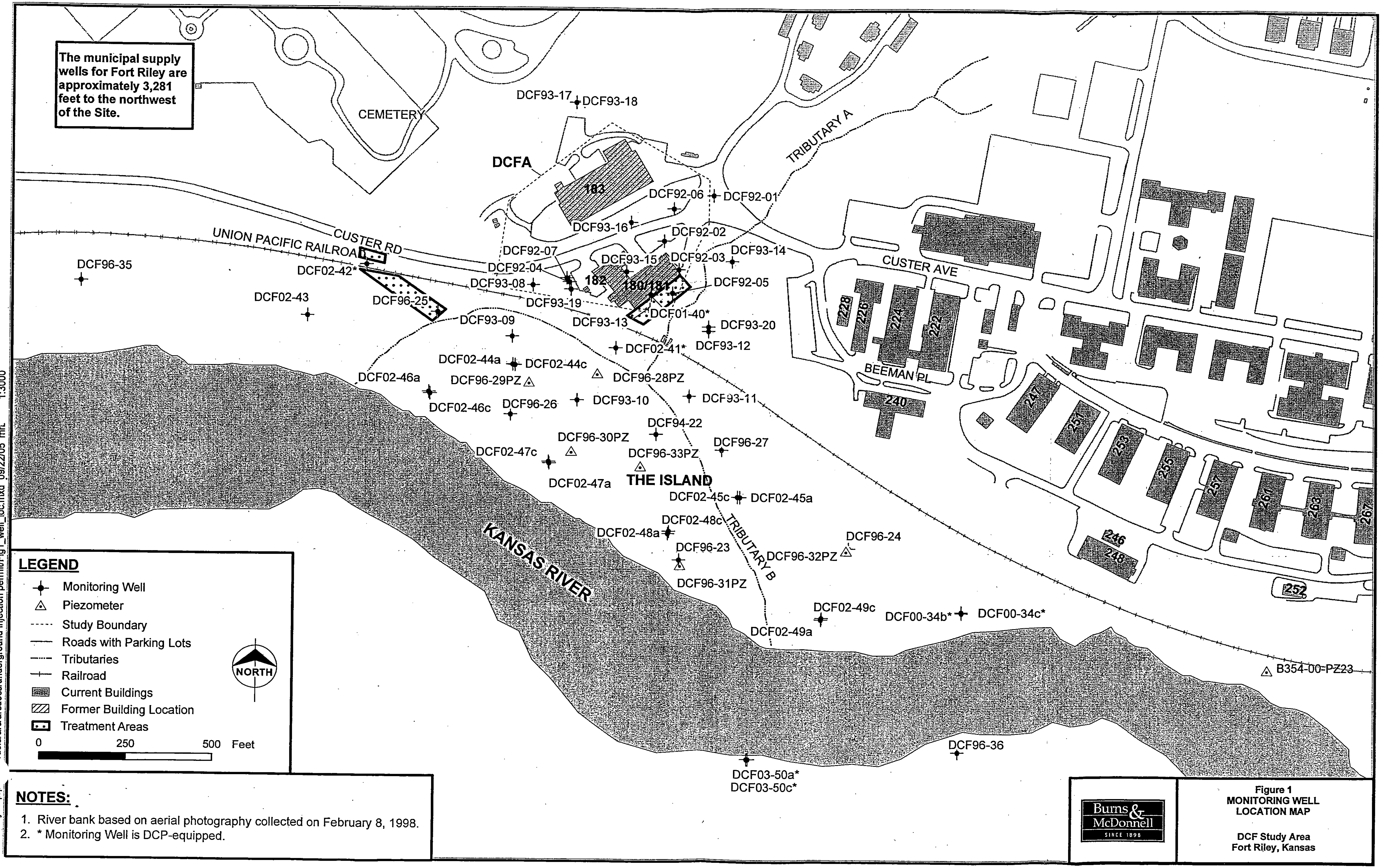
DIVISION OF ENVIRONMENT
Bureau of Water
CURTIS STATE OFFICE BUILDING, 1000 SW JACKSON ST., STE. 420, TOPEKA, KS 66612-1367
Voice 785-296-5524 Fax 785-296.5509 http://www.kdhe.state.ks.us/

If you have any questions, please call me at (785) 296-1843 or email at khoeffne@kdhe.state.ks.us.

Sincerely,

Kirk Hoeffner, L.G.
Unit Chief, Underground Injection Control Program
Geology Section
Bureau of Water

C: Michael Jones – KDHE/SCDO
Mike Cochran→File: DCFA – Fort Riley, Riley Co. Class V – General



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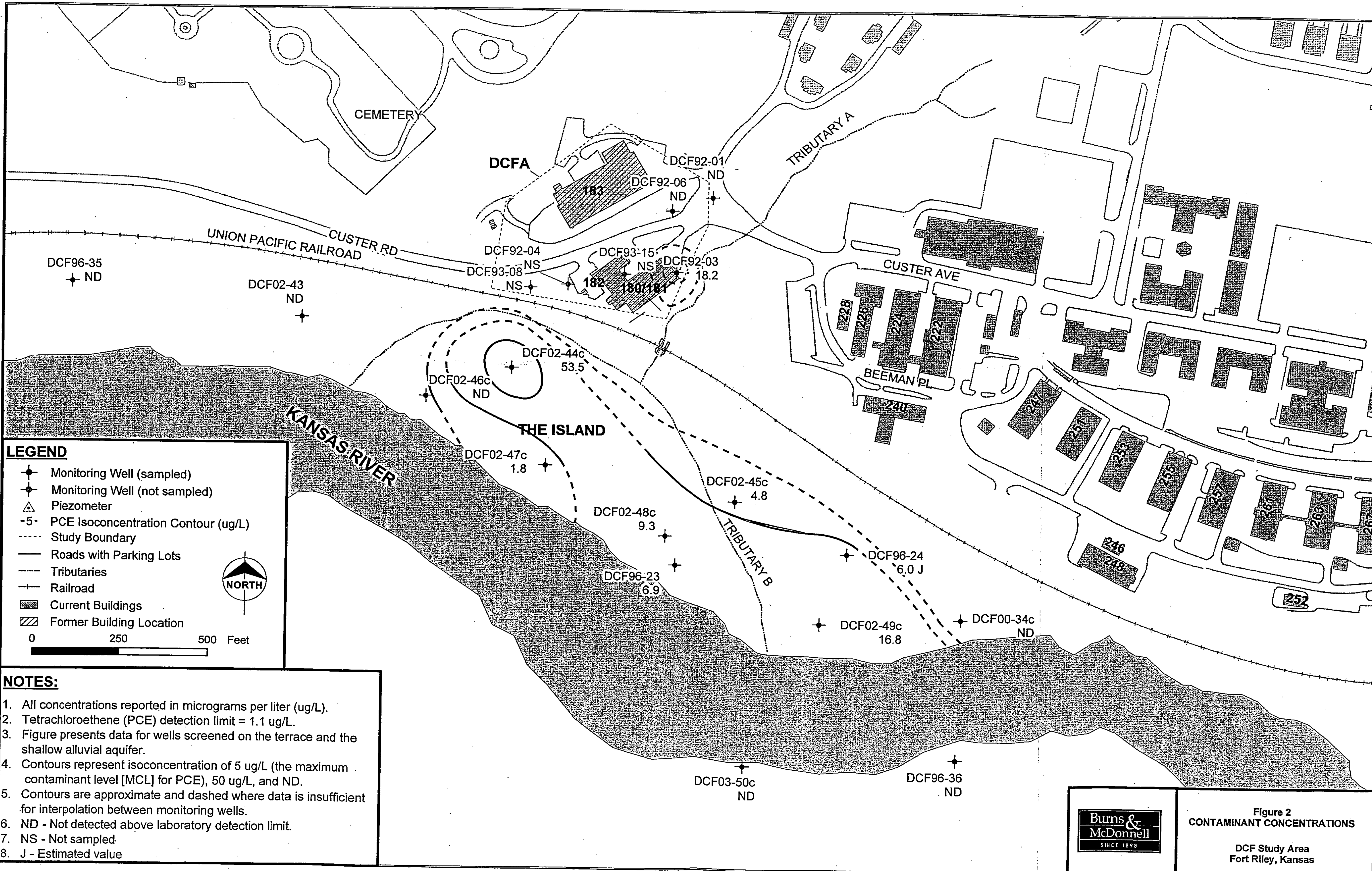

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. Tetrachloroethene (PCE) detection limit = 1.1 ug/L.
3. Figure presents data for wells screened on the terrace and the shallow alluvial aquifer.
4. Contours represent isoconcentration of 5 ug/L (the maximum contaminant level [MCL] for PCE), 50 ug/L, and ND.
5. Contours are approximate and dashed where data is insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled
8. J - Estimated value

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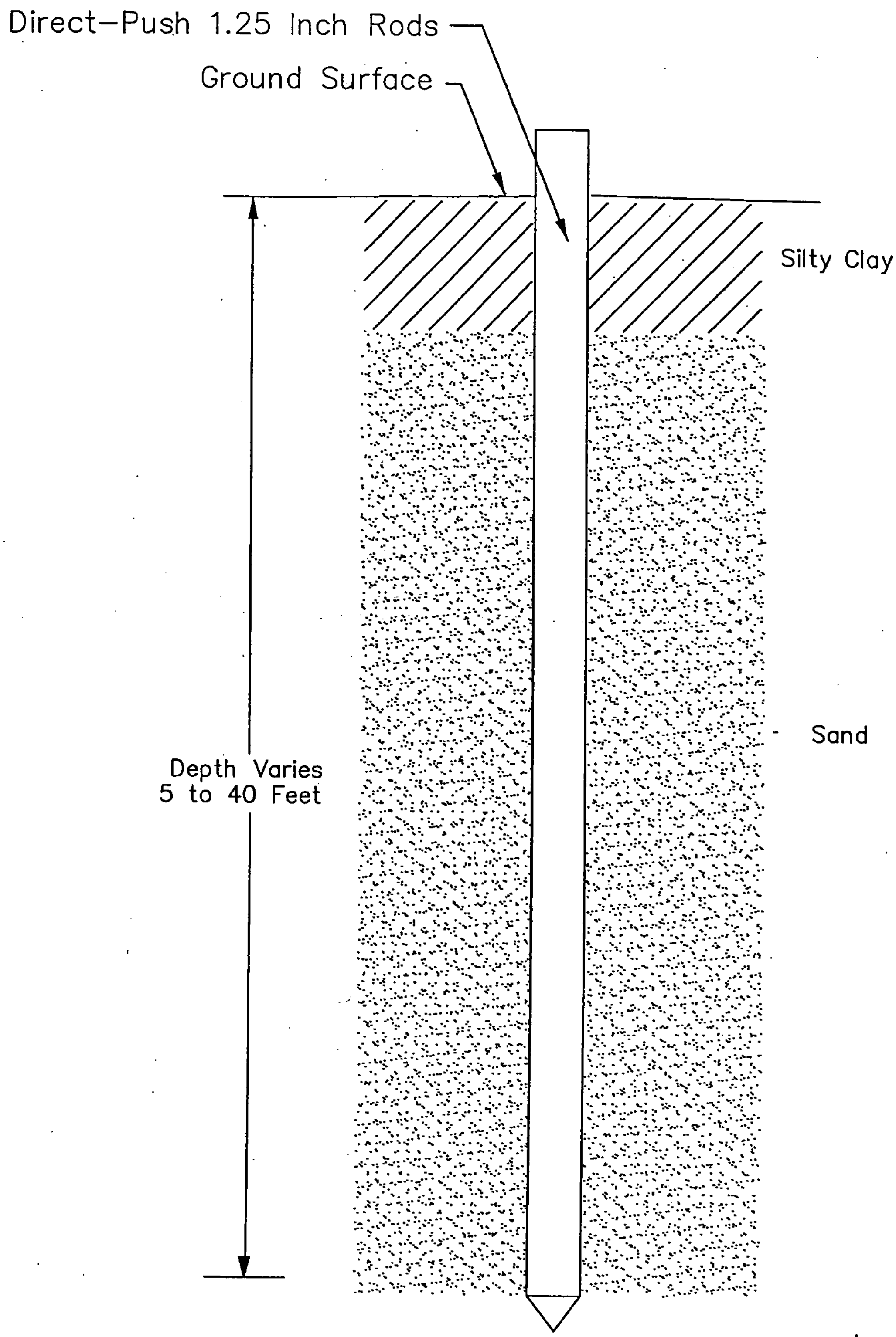

NOT TO SCALE

Burns & McDonnell
SINCE 1898

Figure 3
Typical
Direct-Push
Construction Diagram
DCFA
Fort Riley, Kansas

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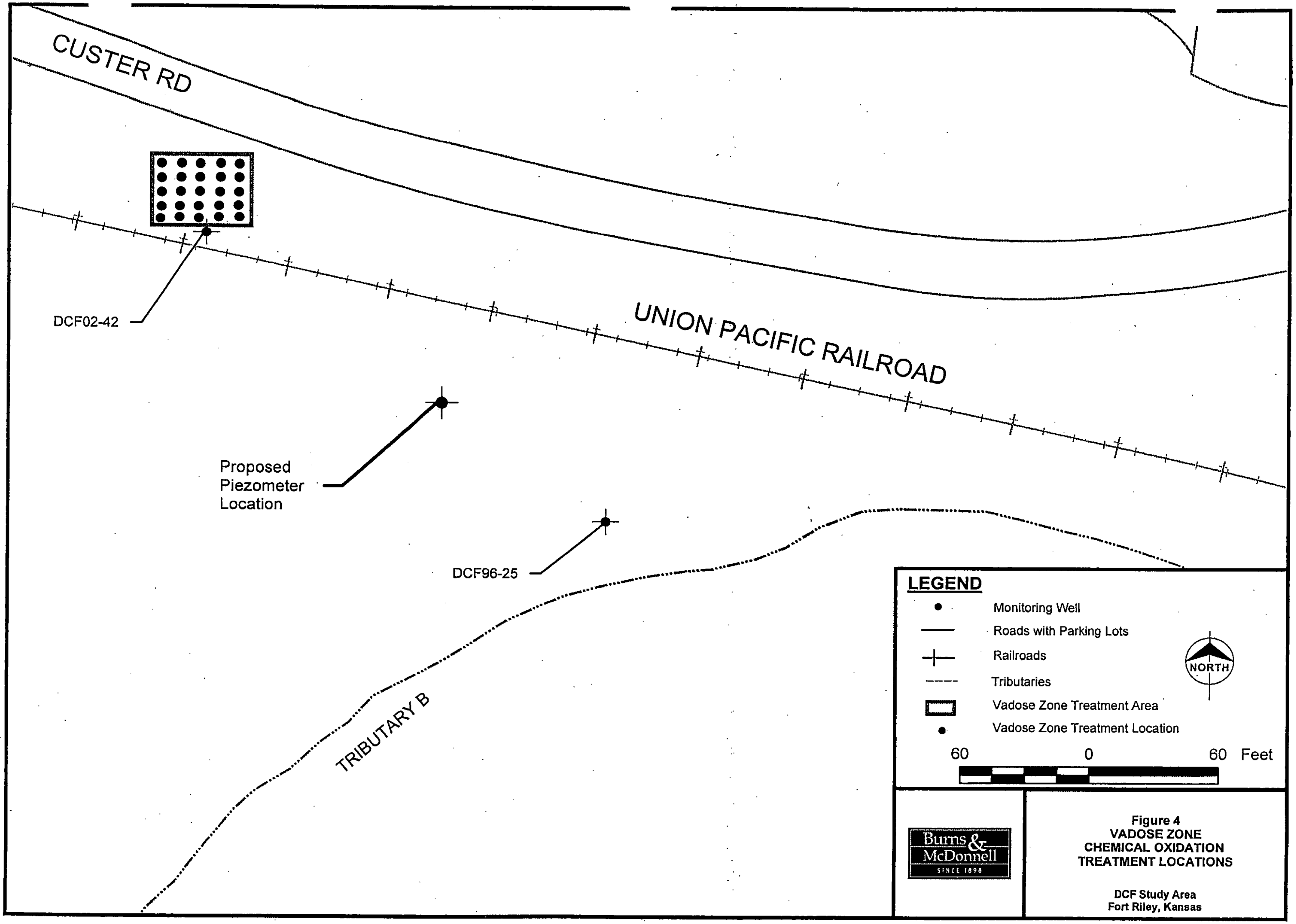

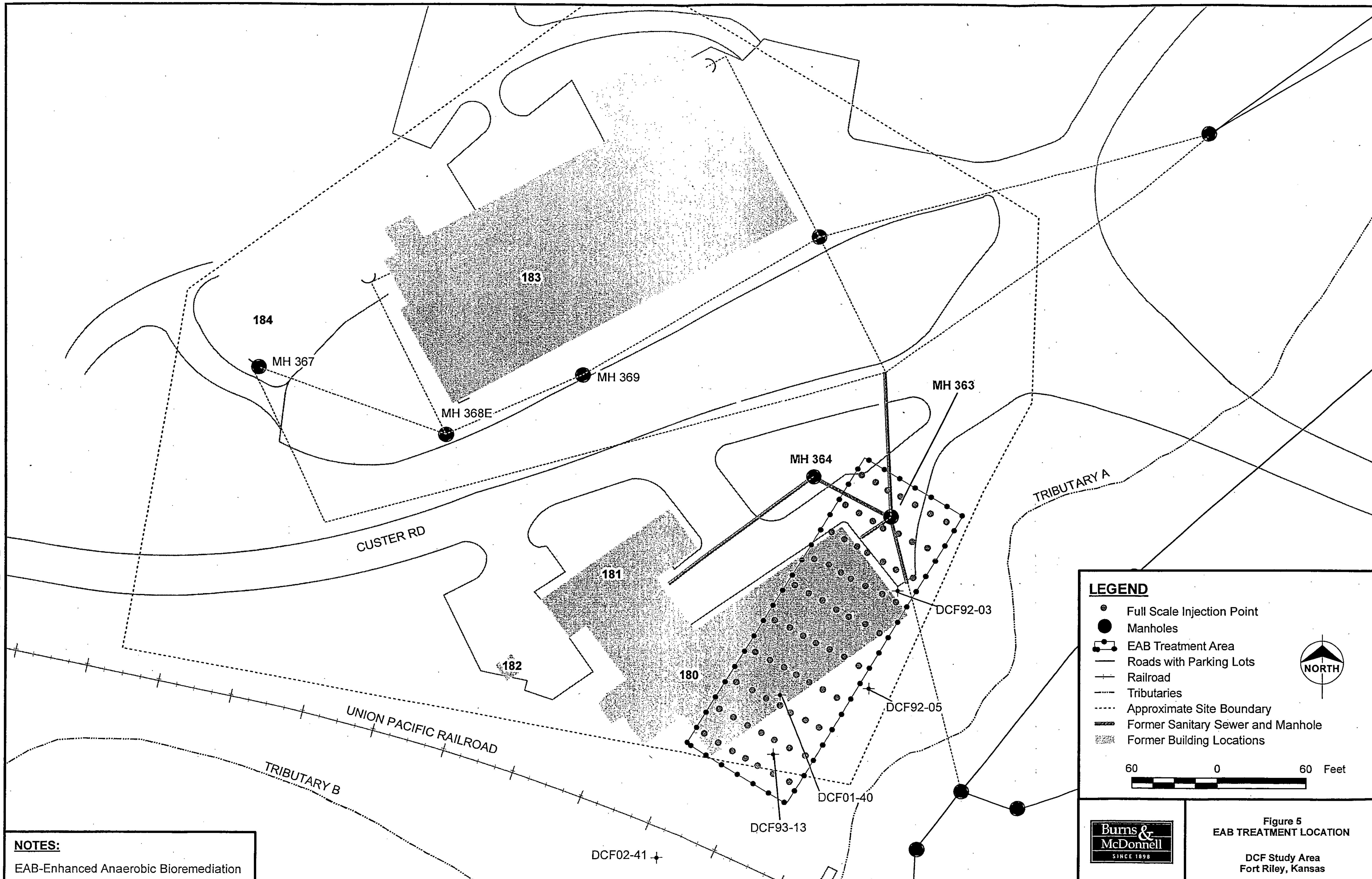

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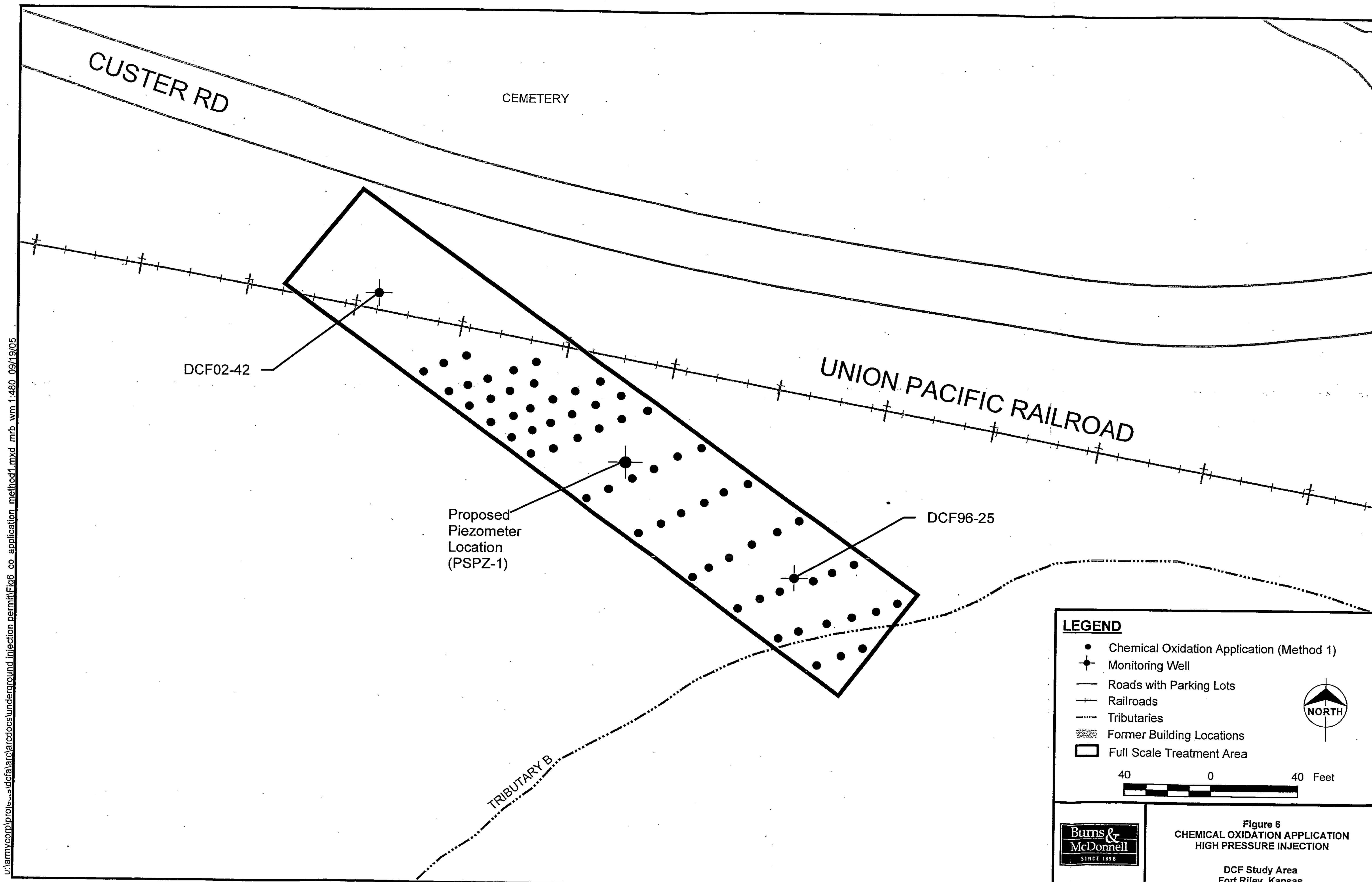

CUSTER RD
CEMETERY
UNION PACIFIC RAILROAD
DCF02-42
Proposed Piezometer Location (PSPZ-1)
DCF96-25
TRIBUTARY B
LEGEND
Chemical Oxidation Application (Method 1)
Monitoring Well
Roads with Parking Lots
Railroads
Tributaries
Former Building Locations
Full Scale Treatment Area
40 0 40 Feet
NORTH
Burns & McDonnell SINCE 1898
Figure 6
CHEMICAL OXIDATION APPLICATION
HIGH PRESSURE INJECTION
DCF Study Area
Fort Riley, Kansas
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Appendix B
Union Pacific Railroad Access Agreement Forms
Right of Entry Agreement
Horizontal Boring Application

Right Of Entry Agreement

February 13, 2006

Folder: 02335-78

MR WALTER B. MCCLENDON
BURNS & MCDONNELL ENGINEERING COMPANY, INC.
9400 WARD PARKWAY
KANSAS CITY MO 64114

Dear Mr. McClendon:

Attached is your original copy of our agreement, fully executed on behalf of the Railroad Company. Please note that pages 1 and 2 reflect changes in the effective and completion dates.

The Railroad Company has authorized the installation of fiber optic cable facilities on its property in certain areas. Prior to using the Railroad Company's property covered herein, you should thoroughly review the terms and conditions of this document and contact the Railroad Company at **1-800-336-9193** to determine if a fiber optic cable is buried on the subject property.

When you or your representative enter the Railroad Company's property, **a copy of this fully-executed document must be available at the site to be shown on request to any Railroad employee or official.**

In compliance with the Internal Revenue Service's new policy regarding their Form 1099, this is to advise you that 94-6001323 is Union Pacific Railroad Company's correct Federal Taxpayer Identification Number and we are doing business as a corporation.

All future insurance notices should be forwarded to:

Union Pacific Railroad Company
(attention: Ernestine W. Burtley - Folder No. 02335-78)
1400 Douglas St. STOP 1690
Omaha, NE 68179-1690

Real Estate

UNION PACIFIC RAILROAD
1400 Douglas Street, Stop 1690
Omaha, Nebraska 68179-1690
fx. (402) 501-0340

In advance of entering the right of way, you should arrange to notify:

Larry Huddleston MTM
Union Pacific Railroad Company
RR1 Box 14
Alexandra KS 67513

Phone: 785-625-7154
Cell: 620-242-5221
Fax: 785-650-0374:

Sincerely yours,

EW Burtley

Ernestine W. Burtley
Manager -Contracts
(402) 544-8801

AUDIT 239593

Folder No. 02335-78

RIGHT OF ENTRY AGREEMENT

THIS AGREEMENT is made and entered into as of March 1, 2006, by and between **UNION PACIFIC RAILROAD COMPANY**, a Delaware corporation (hereinafter the "Railroad"), and **BURNS & MCDONNELL ENGINEERING COMPANY, INC.**, a Missouri corporation, to be addressed at 9400 Ward Parkway, Kansas City, Missouri 64114 (hereinafter the "Licensee").

IT IS MUTUALLY AGREED BY AND BETWEEN THE PARTIES HERETO AS FOLLOWS:

Article I. DEFINITION OF LICENSEE.

For purposes of this Agreement, all references in this Agreement to the Licensee shall include the Licensee's contractors, subcontractors, officers, agents and employees, and others acting under its or their authority.

Article II. RIGHT GRANTED; PURPOSE.

The Railroad hereby grants to the Licensee the right, during the term hereinafter stated and upon and subject to each and all of the terms, provisions and conditions herein contained, to enter upon and have ingress to and egress from the portion of Railroad's property in the vicinity of Mile Post 135.75, Salina Subdivision, at or near Fort Riley, Kansas, for the purpose of moving equipment to remote location. The right herein granted to Licensee is limited to those portions of the Railroad's property specifically described herein in the location shown on the print marked Exhibit A, attached hereto and hereby made a part hereof, or designated by the Railroad Representative named in Article IV.

Article III. TERMS AND CONDITIONS CONTAINED IN EXHIBITS B AND B-1.

The terms and conditions contained in Exhibits B and B-1, hereto attached, are hereby made a part of this Agreement.

Article IV. ALL EXPENSES TO BE BORNE BY LICENSEE; RAILROAD REPRESENTATIVE.

The Licensee shall bear any and all costs and expenses associated with any work performed by the Licensee, or any costs or expenses incurred by the Railroad relating to this Agreement. All work performed by Licensee on Railroad's property shall be performed in a manner satisfactory to the representative local Manager of Track Maintenance of the Railroad or his authorized representative (hereinafter the Railroad Representative):

Larry Huddleston MTM
Union Pacific Railroad Company
RR1 Box 14
Alexandra, Kansas 67513
Phone: 785-625-7154 Cell: 620-242-5221 Fax: 785-650-0374:

Article V. TERM; TERMINATION.

A. The grant of right herein made to Licensee shall commence on the date of this Agreement, and continue until October 15, 2006 unless sooner terminated as herein provided, or at such time as Licensee has completed its work on Railroad's property, whichever is earlier. Licensee agrees to notify the Railroad Representative in writing when it has completed its work on Railroad property.

B. This Agreement may be terminated by either party on ten (10) days written notice to the other party.

Article VI. CERTIFICATE OF INSURANCE.

A. Before commencing any work, the Licensee will provide the Railroad with a Certificate issued by its insurance carrier providing the insurance coverage required pursuant to Exhibit A-1 of this Agreement in a policy which contains the following type of endorsement:

> "Union Pacific Railroad Company is named as additional insured with respect to all liabilities arising out of Insured's, as Licensee, performance of any work on the property of the Railroad."

B. Licensee warrants that this Agreement has been thoroughly reviewed by its insurance agent(s)/broker(s) and that said agent(s)/broker(s) has been instructed to procure insurance coverage and an endorsement as required herein.

C. All insurance correspondence shall be directed to: Union Pacific Railroad Company, Director (Attn.: Ernestine W. Burtley - Folder No.02335-78), 1400 Douglas Street STOP 1690, Omaha, Nebraska 68179-1690.

Article VII. PROTECTION OF FIBER OPTIC CABLE SYSTEMS.

Fiber optic cable systems may be buried on Licensor's property. Protection of the fiber optic cable systems is of extreme importance since any break could disrupt service to users resulting in business interruption and loss of revenue and profits. Prior to beginning any work, the Licensee shall telephone the Railroad at **1-800-336-9193** (a 24-hour number) to determine if fiber optic cable is buried anywhere on the property set forth herein. If it is, the Licensee shall also comply with and be subject to the provisions contained in Section 6 of Exhibit A.

Article VIII. ENFORCEABILITY; CHOICE OF LAW; CHOICE OF FORUM.

This Agreement shall be governed, construed, and enforced in accordance with the laws of the state of Nebraska. Litigation arising out of or connected with this Agreement may be instituted and maintained in the courts of the state of Nebraska and Missouri only, and the parties consent to jurisdiction over their person and over the subject matter of any such litigation, in those courts, and consent to service of process issued by such courts.

Article IX. LICENSE FEE

Licensee shall pay, and Railroad shall accept, upon the execution and return of this instrument, the nonrefundable sum of **One Thousand Five Hundred Dollars ($1,500.00)** to cover Railroad's cost to prepare and administer this Agreement.

Flagging charges are not included in the sum recited in the preceding paragraph, and will be billed separately, if incurred.

Article X. NON-CONTIGENT FEE

Upon execution and delivery of this Agreement, the Licensee shall pay to Railroad an additional, one-time administrative handling change of Five Hundred Forty Five Dollars ($545.00) for clerical, administrative and handling expense in connection with processing this Agreement.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the date first herein written.

UNION PACIFIC RAILROAD COMPANY
Federal Taxpayer I.D. #94-6001323

By: Ernestine Burtley
Manager - Contracts

BURNS & MCDONNELL ENGINEERING COMPANY, INC.

By: [signature]
Title: Assoc. Vice President

(Pursuant to ordinance, resolution, or other evidence of proper authority to execute this instrument, a copy of which shall be attached to the Railroad's original counterpart of this document.)

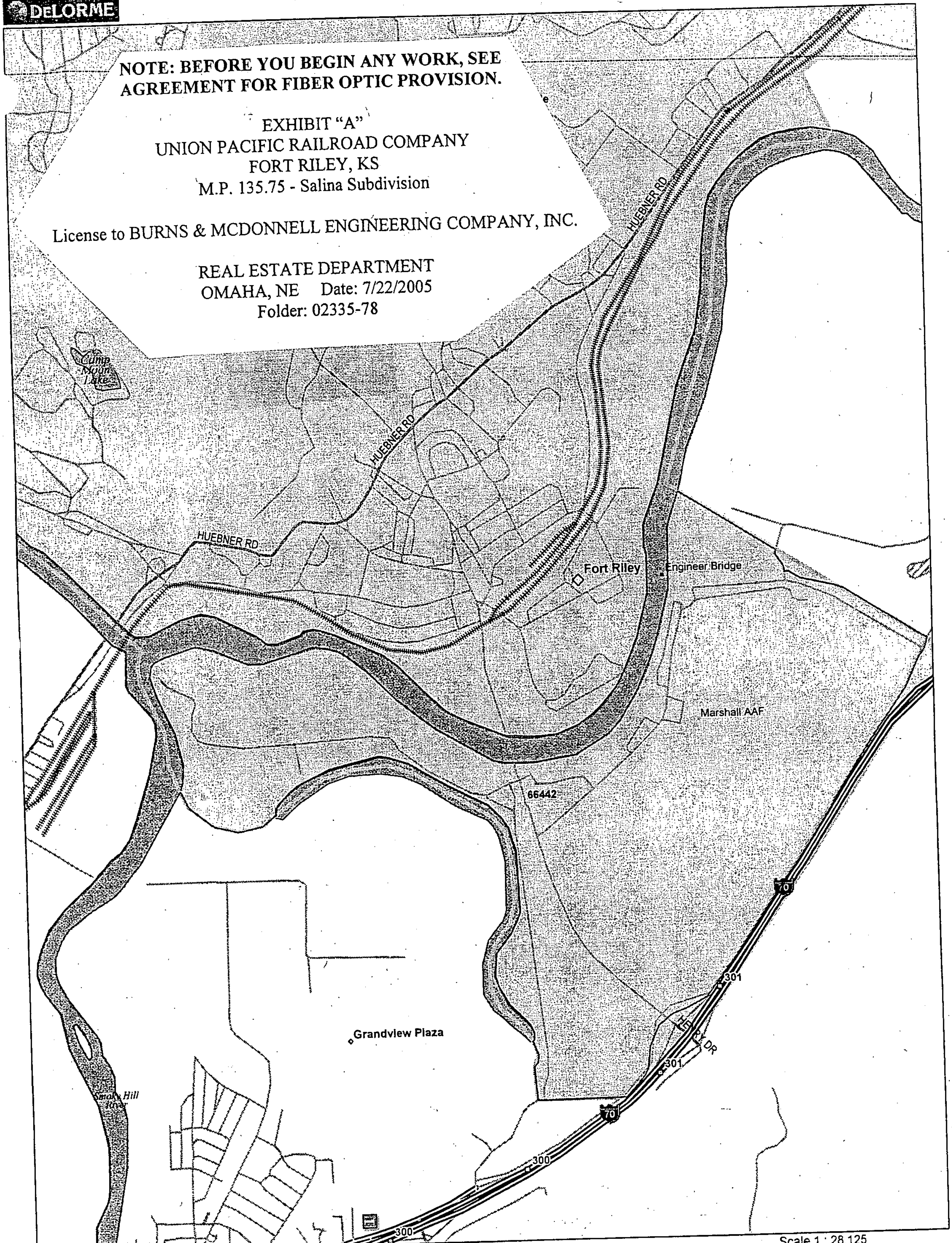
DeLORME

NOTE: BEFORE YOU BEGIN ANY WORK, SEE AGREEMENT FOR FIBER OPTIC PROVISION.

EXHIBIT "A"
UNION PACIFIC RAILROAD COMPANY
FORT RILEY, KS
M.P. 135.75 - Salina Subdivision

License to BURNS & MCDONNELL ENGINEERING COMPANY, INC.

REAL ESTATE DEPARTMENT
OMAHA, NE Date: 7/22/2005
Folder: 02335-78



Scale 1 : 28,125

1" = 2,343.8 ft Data Zoom 12-7

EXHIBIT B

Section 1 - NOTICE OF COMMENCEMENT OF WORK – FLAGGING.

The Licensee agrees to notify the Railroad Representative at least Ten (10) days in advance of Licensee commencing its work and at least 24 hours in advance of proposed performance of any work by the Licensee in which any person or equipment will be within 25 feet of any track, or will be near enough to any track that any equipment extension (such as, but not limited to, a crane boom) will reach to within 25 feet of any track. Upon receipt of such notice, the Railroad Representative will determine and inform the Licensee whether a flagman need be present and whether the Licensee need implement any special protective or safety measures. If any flagmen or other special protective or safety measures are performed by the Railroad, such services will be provided at Licensee's expense with the understanding that if the Railroad provides any flagging or other services, the Licensee shall not be relieved of any of its responsibilities or liabilities set forth herein.

Section 2 - LIMITATION AND SUBORDINATION OF RIGHTS GRANTED.

a. The foregoing grant of right is subject and subordinate to the prior and continuing right and obligation of the Railroad to use and maintain its entire property including the right and power of the Railroad to construct, maintain, repair, renew, use, operate, change, modify or relocate railroad tracks, roadways, signal, communication, fiber optics, or other wirelines, pipelines and other facilities upon, along or across any or all parts of its property, all or any of which may be freely done at any time or times by the Railroad without liability to the Licensee or to any other party for compensation or damages.

b. The foregoing grant is also subject to all outstanding superior rights (including those in favor of licensees and lessees of the Railroad's property, and others) and the right of the Railroad to renew and extend the same, and is made without covenant of title or for quiet enjoyment.

Section 3 - NO INTERFERENCE WITH RAILROAD'S OPERATION.

No work performed by Licensee shall cause any interference with the constant, continuous and uninterrupted use of the tracks, property and facilities of the Railroad, its lessees, licensees or others, unless specifically permitted under this Agreement, or specifically authorized in advance by the Railroad Representative. Nothing shall be done or suffered to be done by the Licensee at any time that would in any manner impair the safety thereof. When not in use, Licensee's machinery and materials shall be kept at least 50 feet from the centerline of Railroad's nearest track, and there shall be no crossings of Railroad's tracks except at existing open public crossings.

Section 4 - PERMITS.

Prior to beginning any work, the Licensee, at its sole expense, shall obtain all necessary permits to perform any work contemplated by this Agreement.

Section 5 - MECHANIC'S LIENS.

The Licensee shall pay in full all persons who perform labor or provide materials for the work to be performed by Licensee. The Licensee shall not create, permit or suffer any mechanic's or materialmen's liens of any kind or nature to be enforced against any property of the Railroad for any such work performed. The Licensee shall indemnify and hold harmless the Railroad from and against any and all liens, claims, demands, costs or expenses of whatsoever nature in any way connected with or growing out of such work done, labor performed, or materials furnished.

Section 6 - FIBER OPTIC CABLE SYSTEMS.

In addition to other indemnity provisions in this Agreement, the Licensee shall indemnify and hold the Railroad harmless from and against all costs, liability and expense whatsoever (including, without limitation, attorneys' fees, court costs and expenses) arising out of any act or omission of the Licensee, its contractor, agents and/or employees, that causes or contributes to (1) any damage to or destruction of any telecommunications system on Railroad's property, and (2) any injury to or death of any person employed by or on behalf of any telecommunications company, and/or its contractor, agents and/or employees, on Railroad's property. Licensee shall not have or seek recourse against Railroad for any claim or cause of action for alleged loss of profits or revenue or loss of service or other consequential damage to a telecommunication company using Railroad's property or a customer or user of services of the fiber optic cable on Railroad's property.

Section 7 - COMPLIANCE WITH LAWS.

In the prosecution of the work covered by this Agreement, the Licensee shall comply with all applicable federal, state and local laws, regulations and enactments affecting the work. The Licensee shall use only such methods as are consistent with safety, both as concerns the Licensee, the Licensee's agents and employees, the officers, agents, employees and property of the Railroad and the public in general. The Licensee (without limiting the generality of the foregoing) shall comply with all applicable state and federal occupational safety and health acts and regulations. All Federal Railroad Administration regulations shall be followed when work is performed on the Railroad's property. If any failure by the Licensee to comply with any such laws, regulations, and enactments, shall result in any fine, penalty, cost or charge being assessed, imposed or charged against the Railroad, the Licensee shall reimburse and indemnify the Railroad for any such fine, penalty, cost or charge, including without limitation attorneys' fees, court costs and expenses. The Licensee further agrees in the event of any such action, upon notice thereof being provided by the Railroad, to defend such action free of cost, charge, or expense to the Railroad.

Section 8 - SAFETY INSTRUCTIONS.

Safety of personnel, property, rail operations and the public is of paramount importance in the prosecution of the work pursuant to this Agreement. As reinforcement and in furtherance of overall safety measures to be observed by the Licensee (and not by way of limitation), the following special safety rules shall be followed:

a. The Licensee shall keep the job site free from safety and health hazards and ensure that its employees are competent and adequately trained in all safety and health aspects of the job. The Licensee shall have proper first aid supplies available on the job site so that prompt first aid services can be provided to any person that may be injured on the job site. The Licensee shall promptly notify the Railroad of any U.S. Occupational Safety and Health Administration reportable injuries occurring to any person that may arise during the work performed on the job site. The Licensee shall have a non-delegable duty to control its employees, while they are on the job site or any other property of the Railroad to be certain they do not use, be under the influence of, or have in their possession any alcoholic beverage or illegally obtained drug, narcotic or other substance that may inhibit the safe performance of work by an employee.

b. The employees of the Licensee shall be suitably dressed to perform their duties safely and in a manner that will not interfere with their vision, hearing or free use of their hands or feet. Only waist length shirts with sleeves and trousers that cover the entire leg are to be worn. If flare-legged trousers are worn, the trouser bottoms must be tied to prevent catching. The employees should wear sturdy and protective footwear. Employees shall not wear boots (other than work boots), sandals, canvas-type shoes or other shoes that have thin soles or heels that are higher than normal. In addition, the Licensee shall require its employees to wear personal protective equipment as specified by Railroad rules, regulations or Railroad officials overlooking the work at the job site. In particular, the protective equipment to be warn shall be:

(1) Protective head gear that meets American National Standard-Z89.1-latest revision. It is suggested that all hardhats be affixed with Licensee's or subcontractor's company logo or name.

(2) Eye protection that meets American National Standard for occupational and educational eye and face protection, Z87.1-latest revision. Additional eye protection must be provided to meet specific job situations such as welding, grinding, burning, etc.; and

(3) Hearing protection which affords enough attenuation to give protection from noise levels that will be occurring on the job site.

c. All heavy equipment provided or leased by the Licensee shall be equipped with audible back-up warning devices. If in the opinion of the Railroad Representative any of Licensee's or any of its subcontractors' equipment is unsafe for use on the Railroad's right-of-way, the Licensee, at the request of the Railroad Representative, shall remove such equipment from the Railroad's right-of-way.

Section 9 - INDEMNITY.

a. As used in this Section, "Railroad" includes other railroad companies using the Railroad's property at or near the location of the Licensee's installation and their officers, agents, and employees; "Loss" includes loss, damage, claims, demands, actions, causes of action, penalties, costs, and expenses of whatsoever nature, including court costs and attorneys' fees, which may result from: (i) injury to or death of persons whomsoever (including the Railroad's officers, agents, and employees, the Licensee's officers, agents, and employees, as well as any other person); and (ii) damage to or loss or destruction of property whatsoever (including Licensee's property, damage to the roadbed, tracks, equipment, or other property of the Railroad, or property in its care or custody).

b. As a major inducement and in consideration of the license and permission herein granted, the Licensee agrees to indemnify and hold harmless the Railroad from any Loss which is due to or arises from any cause and is associated in whole or in part with the work performed under this Agreement, a breach of the Agreement or the failure to observe the health and safety provisions herein, 1 or any activity or omission arising out of performance or nonperformance of this Agreement; regardless of whether caused solely or contributed to in part by the negligence or fault of the Railroad.

c. Any liability of either party hereunder to one of its employees under any Workers' Compensation Act or the Federal Employers' Liability Act shall not be questioned or in any way challenged by the other party, nor shall any jury or court findings, resulting from any employee's suit against either party pursuant to any such Act(s), be relied upon or used by either party in any attempt to assert common law liability against the other.

Section 10 - RESTORATION OF PROPERTY.

In the event the Railroad authorizes the Licensee to take down any fence of the Railroad or in any manner move or disturb any of the other property of the Railroad in connection with the work to be performed by Licensee, then in that event the Licensee shall, as soon as possible and at Licensee's sole expense, restore such fence and other property to the same condition as the same were in before such fence was taken down or such other property was moved or disturbed, and the Licensee shall indemnify and hold harmless the Railroad, its officers, agents and employees, against and from any and all liability, loss, damages, claims, demands, costs and expenses of whatsoever nature, arising from the taking down of any fence or the moving or disturbance of any other property of the Railroad.

Section 11 - WAIVER OF BREACH.

The waiver by the Railroad of the breach of any condition, covenant or agreement herein contained to be kept, observed and performed by the Licensee shall in no way impair the right of the Railroad to avail itself of any remedy for any subsequent breach thereof.

Section 12 - ASSIGNMENT – SUBCONTRACTING.

The Licensee shall not assign, sublet or subcontract this Agreement, or any interest therein, without the written consent of the Railroad and any attempt to so assign, sublet or subcontract without the written consent of the Railroad shall be void. If the Railroad gives the Licensee permission to subcontract all or any portion of the work herein described, the Licensee is and shall remain responsible for all work of subcontractors and all work of subcontractors shall be governed by the terms of this Agreement.

Exhibit B-1
Union Pacific Railroad
Right of Entry

Licensee shall, at its sole cost and expense, procure and maintain during the life of this Agreement the following insurance coverage:

A. **Commercial General Liability** insurance. This insurance shall contain broad form contractual liability with a single limit of at least $5,000,000 each occurrence or claim and an aggregate limit of at least $10,000,000. Coverage must be purchased on a post 1998 ISO or equivalent form, including but not limited to coverage for the following:

- Bodily injury including death and personal injury
- Property damage
- Fire legal liability (Not less than the replacement value of the portion of the premises occupied)
- Products and completed operations

The policy shall also contain the following endorsements, which shall be indicated on the certificate of insurance:

- The employee and worker's compensation related exclusions in the above policy apply only to Licensee's employees
- The exclusions for railroads (except where the Job Site is more than fifty feet (50') from any railroad including but not limited to tracks, bridges, trestles, roadbeds, terminals, underpasses or crossings), and explosion, collapse and underground hazard shall be removed.
- Waiver of subrogation

B. **Business Automobile Coverage** insurance. This insurance shall contain a combined single limit of at least $5,000,000 per occurrence or claim, including but not limited to coverage for the following:

- Bodily injury and property damage
- Any and all motor vehicles including owned, hired and non-owned

The policy shall also contain the following endorsements, **which shall be indicated on the certificate of insurance:**

- The employee and worker's compensation related exclusions in the above policy apply only to Licensee's employees
- The exclusions for railroads (except where the Job Site is more than fifty feet (50') from any railroad including but not limited to tracks, bridges, trestles, roadbeds, terminals, underpasses or crossings), and explosion, collapse and underground hazard shall be removed.
- Motor Carrier Act Endorsement- Hazardous materials clean up (MCS-90) if required by law

C. **Workers Compensation and Employers Liability** insurance including but not limited to:

- Licensee's statutory liability under the workers' compensation laws of the state(s) affected by this Agreement.
- Employers' Liability (Part B) with limits of at least $500,000 each accident, $500,000 disease policy limit $500,000 each employee

If Workers Compensation insurance will not cover the liability of Licensee in states that require participation in state workers' compensation fund, Licensee shall comply with the laws of such states. If Licensee is self-insured, evidence of state approval must be provided along with evidence of excess workers compensation coverage. Coverage shall include liability arising out of the U. S. Longshoremen's and Harbor Workers' Act, the Jones Act, and the Outer Continental Shelf Land Act, if applicable.
The policy shall also contain the following endorsement which shall be indicated on the certificate of insurance:

- Alternate Employer Endorsement

D **Umbrella or Excess Policies** In the event Licensee utilizes Umbrella or excess policies, these policies shall "follow form" and afford no less coverage than the primary policy.

E **Railroad Protective Liability** insurance naming only the Railroad as the insured with a combined single limit of $2,000,000 per occurrence with a $6,000,000 aggregate. The policy shall be broad form coverage for "Physical Damage to Property" (ISO Form CG 00 35 07 98 or equivalent). A binder stating the policy is in place must be submitted to the Railroad until the original policy is forwarded to the Railroad.

Other Requirements

F. Punitive damage exclusion must be deleted, **which deletion shall be indicated on the certificate of insurance.**

G. Licensee agrees to waive its right of recovery, and its insurers, through policy endorsement, agree to waive their right of subrogation against Railroad. Licensee further waives its right of recovery, and its insurers also waive their right of subrogation against Railroad for loss of its owned or leased property or property under its care, custody and control. Licensee's insurance shall be primary with respect to any insurance carried by Railroad. All waivers of subrogation **shall be indicated on the certificate of insurance.**

H. All policy(ies) required above (excluding Workers Compensation) shall provide severability of interests and shall name Railroad as an additional insured. **Severability of interest and naming Railroad as additional insured shall be indicated on the certificate of insurance.**

I. Prior to commencing the Work, Licensee shall furnish to Railroad original certificate(s) of insurance evidencing the required coverage, endorsements, and amendments. The certificate(s) shall contain a provision that obligates the insurance company(ies) issuing such policy(ies) to notify Railroad in writing of any cancellation or material alteration. **Upon request from Railroad, a certified duplicate original of any required policy shall be furnished.**

J. Any insurance policy shall be written by a reputable insurance company acceptable to Railroad or with a current Best's Insurance Guide Rating of A- and Class VII or better, and authorized to do business in the state(s) in which the service is to be provided.

K. Licensee **WARRANTS** that this Agreement has been thoroughly reviewed by Licensee's insurance agent(s)/broker(s), who have been instructed by Licensee to procure the insurance coverage required by this Agreement and acknowledges that Licensees insurance coverage will be primary.

L. If Licensee fails to procure and maintain insurance as required, Railroad may elect to do so at the cost of Licensee plus a 25% administration fee.

M. The fact that insurance is obtained by Licensee or Railroad on behalf of Licensee shall not be deemed to release or diminish the liability of Licensee, including, without limitation, liability under the indemnity provisions of this Agreement. Damages recoverable by Railroad shall not be limited by the amount of the required insurance coverage.

Horizontal Boring Application

February 27, 2006

Union Pacific Railroad
ATTN: Ms. Ernestine W. Burtley
Manager - Contracts
1400 Douglas Street, Stop 1690
Omaha, Nebraska 68179-1690

Boring Application
Associated Folder: 02335-78
Dry Cleaning Facilities Area
Department of the Army
Fort Riley, Kansas

Ms Burtley:

Attached for your review is a horizontal boring application for installing three 4-inch steel casing pipes spaced one foot apart. These borings will be installed beneath the railroad tracks and grade at the Dry Cleaning Facilities Area for the United States Army Corps of Engineers at Fort Riley, Kansas. We are requesting approval for these borings so that we can insert carrier pipe/hose through the steel casing from the area north of the tracks to the Island area south of the tracks. The Island area is a conservation habitat for migratory bald eagles and is considered a protective area. To minimize damage to this protective area, Burns & McDonnell is requesting approval of this application.

Horizontal boring work is scheduled to proceed on April 10th, 2006. Work on the Island will commence on the April 17th, 2006 and continue for approximately six weeks. Following completion of the remediation activities on the Island, the carrier pipe/hoses will be withdrawn and the three 4-inch steel casing pipes will be filled with concrete.

If you have any questions, please feel free call me at (816) 822-4357 or Tom Zychinski at 636-305-0077, ext 237.

Sincerely,

Walter B McClendon, P.G.

Enclosures

APPLICATION

1). Name of Licensee: Burns & McDonnell
(Name to be shown on Document)

a) If a corporation Burns & McDonnell Engineering Company, Incorporated
(Exact name of Corporation)

a corporation of the State of Missouri
(State of Incorporation)

NOTE: The corporate name of a company should be exactly as stated in its Articles of Incorporation. Type of Corporation, if other than a normal business corporation, MUST be shown:

____
(Municipal, quasi-municipal, body politic, etc.)

b) If an Individual ______________________________
(Name of Individual)

of ______________________________
(City & State)

c) If an individual or corporation doing business under a trade name:

____
(Doing Business As or Trade Name)

d) If a partnership ______________________________
(Name of Partnership)

A partnership consisting of:

____

and ______________________________

all of ______________________________
(City & State)

2). Address of Licensee:
9400 Ward Parkway, Kansas City, MO 64114; Attn: Walter McClendon

3). Name and mailing address of individual to whom instrument is to be sent for execution if different than shown in Item 2:
N/A (same as 2)
(Name & Address)

4). Billing address if different than shown in Item 2:
N/A (same as 2)
(Address)

5). Name and phone number of individual to contact in event of questions:
Walter McClendon Phone: 816-333-9400 x-4357 Fax: 816-822-3494

6).a) Do you plan to utilize the right-of-way for a public use (for a utility crossing)? ( ) Yes (X) No

b) Do you have authority to utilize the right-of-way for a public use by condemnation? N/A ( ) Yes ( ) No

c) Will you initiate condemnation proceedings to acquire the subject property in the event negotiations are unsuccessful? N/A ( ) Yes ( ) No

7). When do you expect construction to begin on the Railroad Company's property? April 10, 2006

8). When do you need to receive this agreement from the Railroad Company? April 1, 2006
(Please allow 30-45 days for crossings and 90-120 days for encroachments)

9). Permanent or Temporary Installation - Permanent, steel casing pipe; temporary, carrier pipe/hose

If Temporary, estimated term - The carrier pipes will be used for an estimated 6 weeks and then they will be removed. The casing pipe will be capped or filled with grout and left in-place.

10). Location of installation - Fort Riley, Geary County, Kansas
(City, County & State)

N/A (Military Base) ft. (N), (S), (E), or (W) of the (N), (S), (E), (W) or (Center) line of Section N/A

Township N/A (N) or (S), Range N/A (E) or (W).N/A

11). New installation, relocation or modification of existing installation which is located on the Railroad Company's property or across tracks?
New Installation

12). Do you have an existing agreement at this location with the Railroad Company which is to be affected by this request?
(X) No ( ) Yes, Railroad Company Contract Number: ______

13). Is installation a crossing Crossing or encroachment ______ or both? ______

14). Is installation located within a dedicated public street? No X
Yes ______ , enclosed are records which identify and prove the dedication of such public way.

15). Additional information pertinent to this installation:
We are requesting a variance from the 25 ft. minimum cover below base of rail given in Union Pacific's "Interim Guidelines for Horizontal Directional Drilling Under Union Pacific Railroad Right-of-Way." Due to access limitations because of the locations of Custer Road and the gas and fiber optic utility lines north of Union Pacific's track in the area of the proposed crossing (see Attached Figure 2) and access limitations south of the track because of the eagle nesting area, the casing pipe will be installed approximately 9 ft. below base of rail (see Attached Figure 3). However, this proposed depth meets the minimum depth requirement of 4.5 ft. below rail given in Union Pacific's "Pipeline Installation Engineering Specifications." Our proposal meets all other requirements and specifications given in the above-referenced Union Pacific documents.

16). If an encroachment, who will be served?
N/A
(Railroad, Railroad Tenant, General Public, etc.)

17). Did the Railroad Company's magazine advertisement affect your decision to utilize the right-of-way for a utility corridor?
( ) Yes ( ) No. If not, did another medium impress your decision? ( ) Yes ( ) No N/A

If applicable, please advise other medium: ______

CONTRACTOR AND INSTALLATION INFORMATION

18). Will construction be by a Contractor? ( ) No (X) Yes

If yes, Contractor will be: M & D Excavating of Hays, KS, Inc.

Address: 1116 East 8th Street, Hays, KS 67601

Corporate Status: Corporation

Name and Phone Number of individual to contact in the event of questions:
Vaughn McMurtrie 785-628-3169 (office): 785-650-3806 (cell phone)

19). Describe in detail the method and manner of installation on the Railroad Company's property:
Based upon the limited area for boring activities described in the response to question 15, the method and manner of casing pipe installation will follow the Boring Plan detailed by M&D Excavation (see Attached). In general, a 3 ft. by 3 ft. by 5 ft. (depth) pit will be dug off of Union Pacific property approximately 40 ft. north of the Union Pacific track to allow proper access for the horizontal drilling equipment and to meet Union Pacific and project specifications. A total of 3, 4-inch O.D. steel casing pipes will be installed spaced approximately 1 ft. apart starting within the excavated pit. The exit pit on the south side of the track will be off Union Pacific property approximately 40 ft. south of the track. The pit will be hand-dug to a depth of approximately 3 ft. to expose each of the casing pipes due to access restrictions within the eagle nesting area. Carrier pipe/hose will be installed in 2 of the casing pipes, and the third casing pipe will be used as a spare (see Exhibit A sheets, 1 for each casing pipe). The carrier pipe/hose will be temporary. They will be in use for an estimated 6 weeks, and then they will be removed. The casing pipe will then be either capped or filled with grout.

Exhibit A Sheets
(3 sheets)

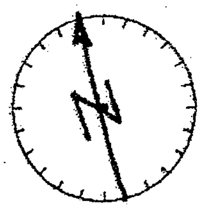
PLACE ARROW INDICATING NORTH DIRECTION RELATIVE TO CROSSING

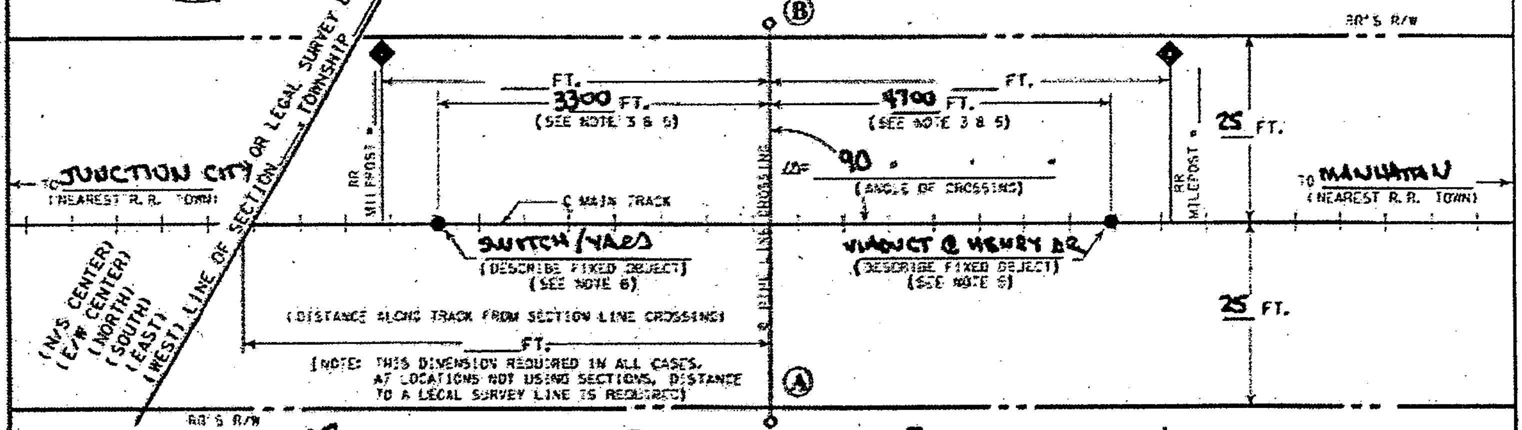
FORM OR-0404-B
REV. 5-15-98

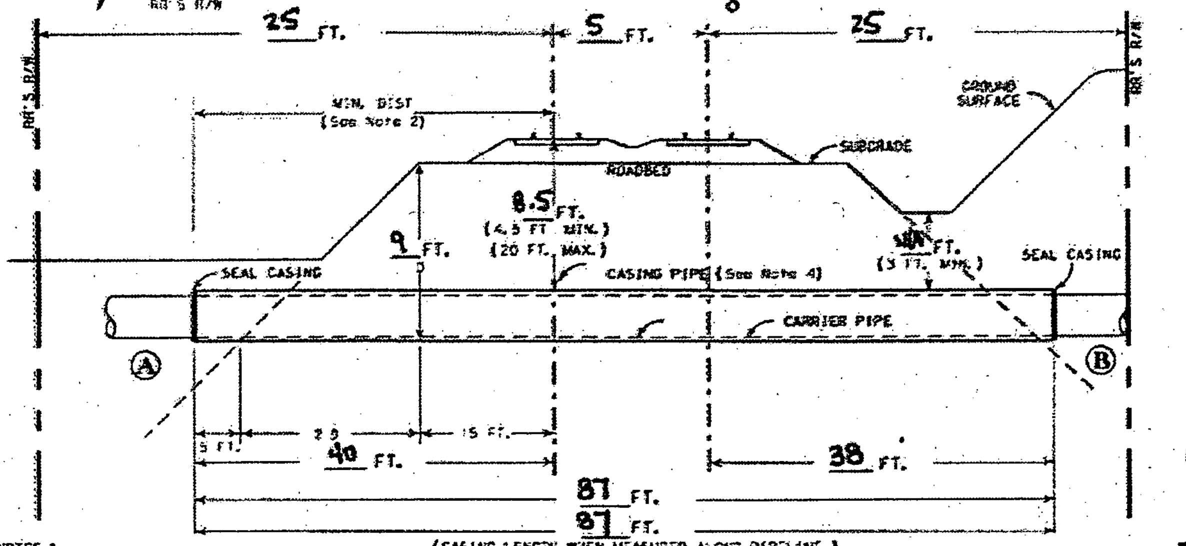
ENCASED NON-FLAMMABLE PIPELINE CROSSING

NOTE: ALL AVAILABLE DIMENSIONS MUST BE FILLED IN TO PROCESS THIS APPLICATION.

NO SCALE





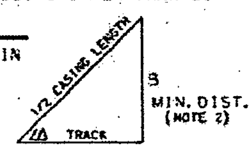


STEEL CASING WALL THICKNESS CHART		
MINIMUM THICKNESS		DIAMETER OF CASING PIPE
.2500"	1/4"	12" OR LESS
.3125"	5/16"	OVER 12"-18"
.3750"	3/8"	OVER 18"-22"
.4375"	7/16"	OVER 22"-28"
.5000"	1/2"	OVER 28"-34"
.5625"	9/16"	OVER 34"-42"
.6250"	5/8"	OVER 42"-48"
OVER 48" MUST BE APPROVED BY R.R. CO.		

NOTE: THIS CHART IS ONLY FOR SMOOTH STEEL CASING PIPES WITH MINIMUM YIELD STRENGTH OF 35,000 PSI.

FORMULA TO FIGURE CASING LENGTH WITH ANGLE OF CROSSING OTHER THAN 90°

$\frac{B}{\Delta \text{ SIN}}$



NOTES:
1) ALL HORIZONTAL DISTANCES TO BE MEASURED AT RIGHT ANGLES FROM ℄ OF TRACK.
2) CASING TO EXTEND BEYOND THE ℄ OF TRACK AT RIGHT ANGLES THE GREATER OF 20 + 20 FT., OR 30 FT., AND BEYOND LIMIT OF RAILROAD RIGHT-OF-WAY IF NECESSARY TO PROVIDE PROPER LENGTH OUTSIDE OF TRACK.
3) MINIMUM OF 50' FROM THE END OF ANY RAILROAD BRIDGE, ℄ OF ANY CULVERT, OR FROM ANY SWITCHING AREA.
4) SIGNAL REPRESENTATIVE MUST BE PRESENT DURING INSTALLATION IF RAILROAD SIGNALS ARE IN THE VICINITY OF CROSSING.
5) ALLOWABLE FIXED OBJECTS INCLUDE: BACKWALLS OF BRIDGES; ℄ OF ROAD CROSSINGS & OVERHEAD VIADUCTS (GIVE ROAD NAME), OR CULVERTS.
6) CASING AND CARRIER PIPE MUST BE PLACED A MINIMUM OF 2 FEET BELOW THE EXISTING FIBER OPTIC CABLE. ANY EXCAVATION REQUIRED WITHIN 5 FEET OF THE EXISTING FIBER OPTIC CABLE MUST BE HAND DUG.

A) IS PIPELINE CROSSING WITHIN DEDICATED STREET ? ____ YES; X NO;
B) IF YES, NAME OF STREET N/A
D) DISTRIBUTION LINE X OR TRANSMISSION LINE ____
C) CARRIER PIPE : TEMPORARY (6 WEEKS)
COMMODITY TO BE CONVEYED WATER
OPERATING PRESSURE 10,000 PSI
WALL THICKNESS 0.625" ; DIAMETER 1.19" ; MATERIAL SYNTHETIC RUBBER ;
E) CASING PIPE :
WALL THICKNESS 0.312" ; DIAMETER 3.876" ; MATERIAL STEEL ;
NOTE : CASING MUST HAVE 2" CLEARANCE BETWEEN GREATEST OUTSIDE DIAMETER OF CARRIER PIPE AND INTERIOR DIAMETER OF CASING PIPE. WHEN FURNISHING DIMENSIONS, GIVE OUTSIDE OF CARRIER PIPE AND INSIDE OF CASING PIPE.
F) METHOD OF INSTALLING CASING PIPE UNDER TRACK(S):
X DRY BORE AND JACK (WET BORE NOT PERMITTED) ;
____ TUNNEL ; OTHER ____
) WILL CONSTRUCTION BE BY AN OUTSIDE CONTRACTOR? X YES; ____ NO;
H) DISTANCE FROM CENTER LINE OF TRACK TO NEAR FACE OF BORING AND JACKING PITS WHEN MEASURED AT RIGHT ANGLES TO TRACK 38 (30' MIN.)
I) APPLICANT HAS CONTACTED 1-800-336-9193, U. P. COMMUNICATION DEPARTMENT, AND HAS DETERMINED FIBER OPTIC CABLE X DOES ; ____ DOES NOT ; EXIST IN VICINITY OF WORK TO BE PERFORMED . TICKET NO. 2006022100S

EXHIBIT "A"

(FOR RAILROAD USE ONLY)

UNION PACIFIC RAILROAD CO.

____
(SUBDIVISION)

M. P ____ E. S. ____

ENCASED ____ CROSSING AT

____
(NEAREST CITY) (COUNTY) (STATE)

____
(APPLICANT)

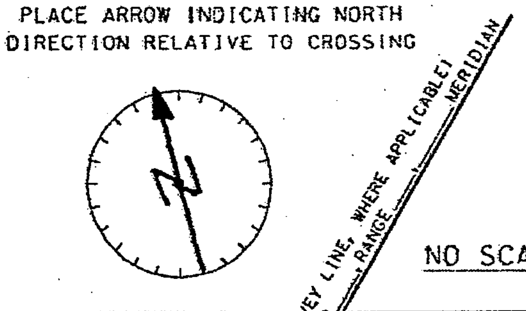
RR FILE NO. ____ DATE ____

WARNING

IN ALL OCCASIONS, U. P. COMMUNICATIONS DEPARTMENT MUST BE CONTACTED IN ADVANCE OF ANY WORK TO DETERMINE EXISTENCE AND LOCATION OF FIBER OPTIC CABLE. PHONE : 1-800-336-9193

FORM DR-0404-B
REV. 5-15-98

PLACE ARROW INDICATING NORTH DIRECTION RELATIVE TO CROSSING



ENCASED NON-FLAMMABLE PIPELINE CROSSING

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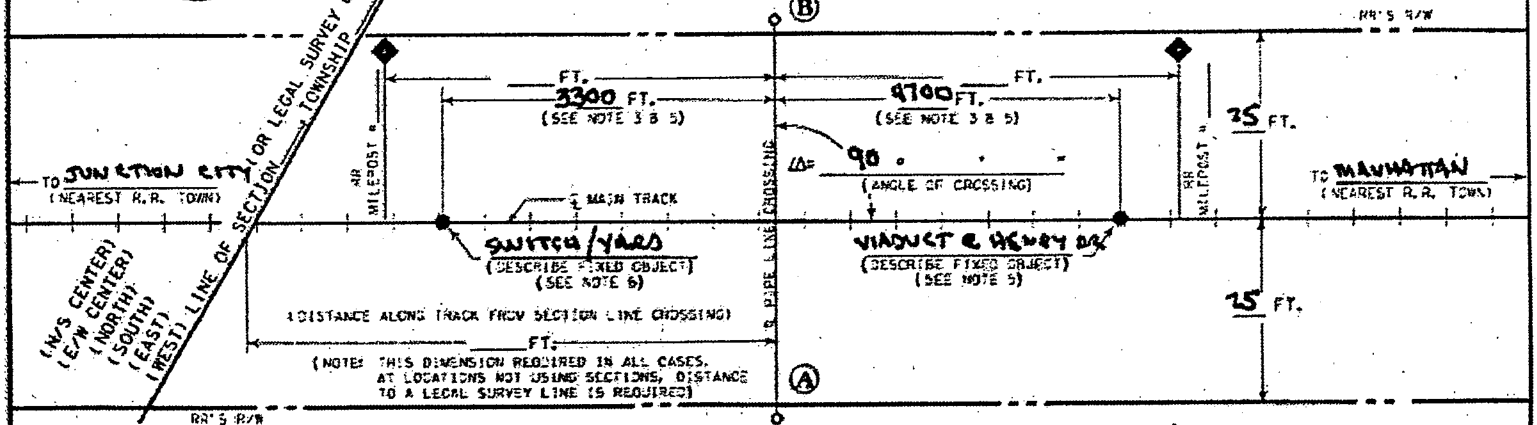
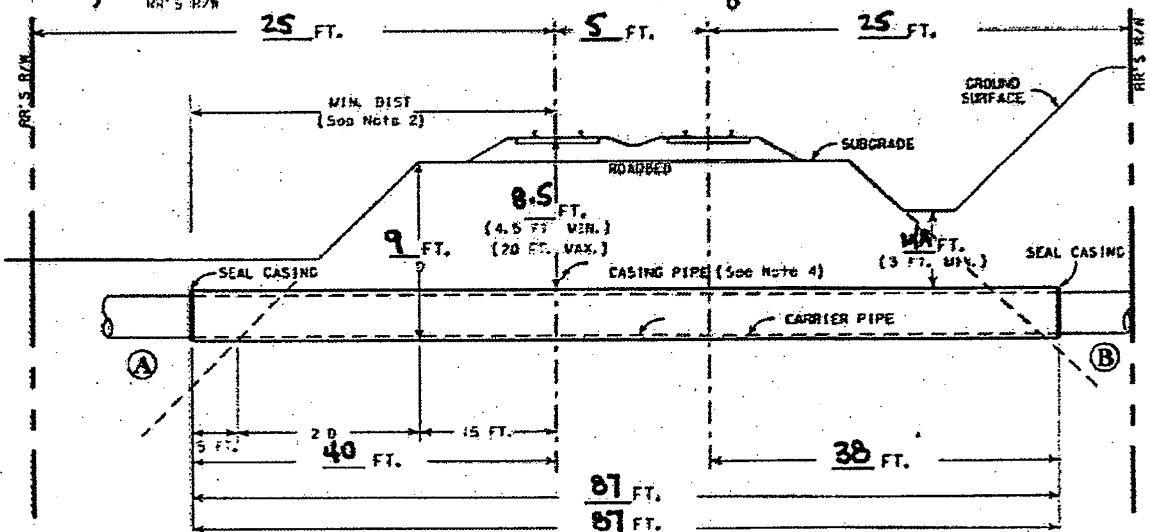
NO SCALE





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.4375"	7/16"	OVER 27
.5000"	1/2"	OVER 2
.5625"	9/16"	OVER 3
.6250"	5/8"	OVER 42"-48"

OVER 48" MUST BE APPROVED BY R.R. CO.

NOTE: THIS CHART IS ONLY FOR SMOOTH STEEL CASING PIPES WITH MINIMUM YIELD STRENGTH OF 35,000 PSI.

FORMULA TO FIGURE CASING LENGTH WITH ANGLE OF CROSSING OTHER THAN 90°

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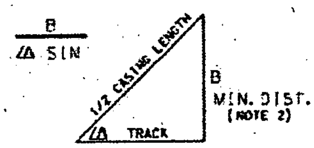

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B) IF YES, NAME OF STREET N/A
D) DISTRIBUTION LINE X OR TRANSMISSION LINE ____
C) CARRIER PIPE : TEMPORARY (6 WEEKS)
COMMODITY TO BE CONVEYED PERMANGANATE
OPERATING PRESSURE 300 PSI
WALL THICKNESS 0.14" ; DIAMETER 1.875" ; MATERIAL STEEL ;
E) CASING PIPE :
WALL THICKNESS 0.312" ; DIAMETER 3.876" ; MATERIAL STEEL ;
NOTE : CASING MUST HAVE 2" CLEARANCE BETWEEN GREATEST OUTSIDE DIAMETER OF CARRIER PIPE AND INTERIOR DIAMETER OF CASING PIPE. WHEN FURNISHING DIMENSIONS, GIVE OUTSIDE OF CARRIER PIPE AND INSIDE OF CASING PIPE.
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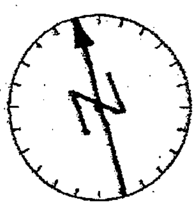
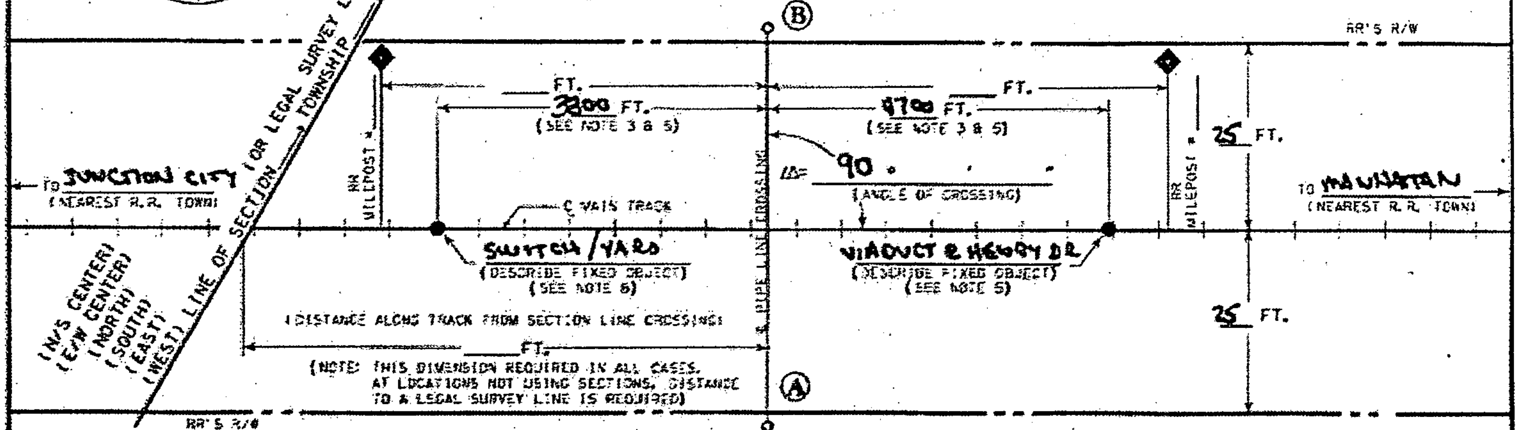


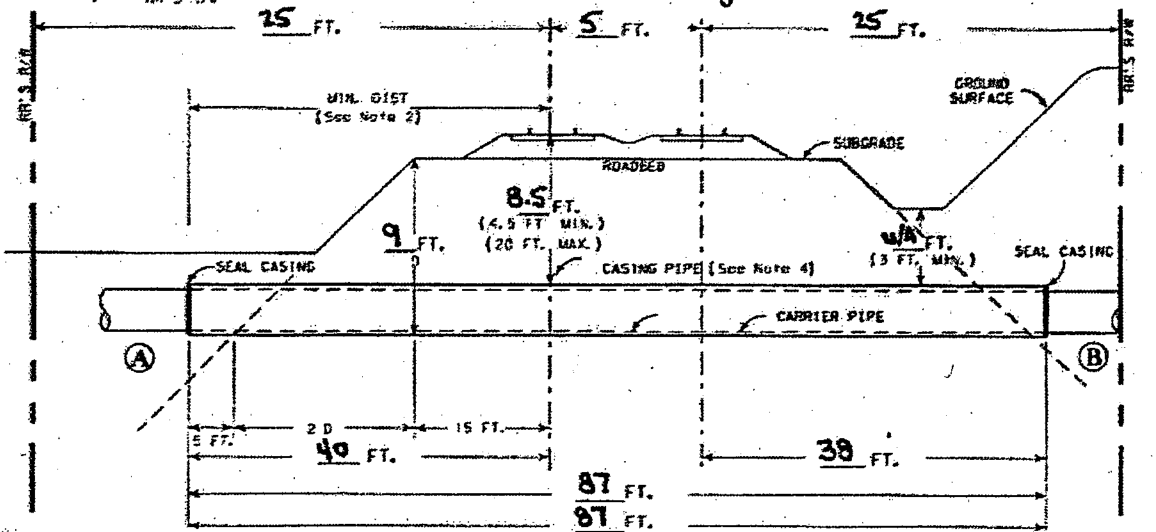
FORM DR-0404-B
REV. 5-15-98

ENCASED NON-FLAMMABLE PIPELINE CROSSING

NO SCALE

NOTE: ALL AVAILABLE DIMENSIONS MUST BE FILLED IN TO PROCESS THIS APPLICATION.





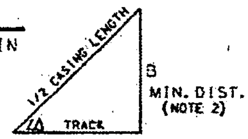
STEEL CASING WALL THICKNESS CHART		
MINIMUM THICKNESS		DIAMETER OF CASING PIPE
.2500"	1/4"	12" OR LESS
.3125"	5/16"	OVER 12"-18"
.3750"	3/8"	OVER 18"-22"
.4375"	7/16"	OVER 22"-28"
.5000"	1/2"	OVER 28"-34"
.5625"	9/16"	OVER 34"-42"
.6250"	5/8"	OVER 42"-48"

OVER 48" MUST BE APPROVED BY R.R. CO.

NOTE: THIS CHART IS ONLY FOR SMOOTH STEEL CASING PIPES WITH MINIMUM YIELD STRENGTH OF 35,000 PSI.

FORMULA TO FIGURE CASING LENGTH WITH ANGLE OF CROSSING OTHER THAN 90°

$\frac{B}{\angle\ \mathrm{SIN}}$



NOTES:
1) ALL HORIZONTAL DISTANCES TO BE MEASURED AT RIGHT ANGLES FROM ℄ OF TRACK.
2) CASING TO EXTEND BEYOND THE ℄ OF TRACK AT RIGHT ANGLES THE GREATER OF 2D + 20 FT., OR 30 FT., AND BEYOND LIMIT OF RAILROAD RIGHT-OF-WAY IF NECESSARY TO PROVIDE PROPER LENGTH OUTSIDE OF TRACK.
3) MINIMUM OF 50' FROM THE END OF ANY RAILROAD BRIDGE, ℄ OF ANY CULVERT, OR FROM ANY SWITCHING AREA.
4) SIGNAL REPRESENTATIVE MUST BE PRESENT DURING INSTALLATION IF RAILROAD SIGNALS ARE IN THE VICINITY OF CROSSING.
5) ALLOWABLE FIXED OBJECTS INCLUDE: BACKWALLS OF BRIDGES; ℄ OF ROAD CROSSINGS & OVERHEAD VIADUCTS (GIVE ROAD NAME), OR CULVERTS.
6) CASING AND CARRIER PIPE MUST BE PLACED A MINIMUM OF 2 FEET BELOW THE EXISTING FIBER OPTIC CABLE. ANY EXCAVATION REQUIRED WITHIN 5 FEET OF THE EXISTING FIBER OPTIC CABLE MUST BE HAND DUG.

A) IS PIPELINE CROSSING WITHIN DEDICATED STREET ? ____ YES; X NO;
B) IF YES, NAME OF STREET N/A
D) DISTRIBUTION LINE X OR TRANSMISSION LINE ____
C) CARRIER PIPE : N/A... TO BE USED AS SPARE
COMMODITY TO BE CONVEYED ____
OPERATING PRESSURE ____ PSI
WALL THICKNESS ____; DIAMETER ____; MATERIAL ____;
E) CASING PIPE :
WALL THICKNESS 0.312"; DIAMETER 3.876"; MATERIAL STEEL;
NOTE : CASING MUST HAVE 2" CLEARANCE BETWEEN GREATEST OUTSIDE DIAMETER OF CARRIER PIPE AND INTERIOR DIAMETER OF CASING PIPE. WHEN FURNISHING DIMENSIONS, GIVE OUTSIDE OF CARRIER PIPE AND INSIDE OF CASING PIPE.
F) METHOD OF INSTALLING CASING PIPE UNDER TRACK(S):
X DRY BORE AND JACK (WET BORE NOT PERMITTED) ;
____ TUNNEL ; OTHER ____
WILL CONSTRUCTION BE BY AN OUTSIDE CONTRACTOR? X YES; ____ NO;
H) DISTANCE FROM CENTER LINE OF TRACK TO NEAR FACE OF BORING AND JACKING PITS WHEN MEASURED AT RIGHT ANGLES TO TRACK 38 (30' MIN.)
I) APPLICANT HAS CONTACTED 1-800-336-9193, U. P. COMMUNICATION DEPARTMENT, AND HAS DETERMINED FIBER OPTIC CABLE X DOES ; ____ DOES NOT ; EXIST IN VICINITY OF WORK TO BE PERFORMED . TICKET NO. 2006 0221005

EXHIBIT "A"

(FOR RAILROAD USE ONLY)

UNION PACIFIC RAILROAD CO.

____
(SUBDIVISION)

M. P ____ E. S. ____

ENCASED ____ CROSSING AT

____
(NEAREST CITY) (COUNTY) (STATE)

____
(APPLICANT)

RR FILE NO. ____ DATE ____

WARNING

IN ALL OCCASIONS, U. P. COMMUNICATIONS DEPARTMENT MUST BE CONTACTED IN ADVANCE OF ANY WORK TO DETERMINE EXISTENCE AND LOCATION OF FIBER OPTIC CABLE.
PHONE : 1-800-336-9193

Figures

(3 Figures)

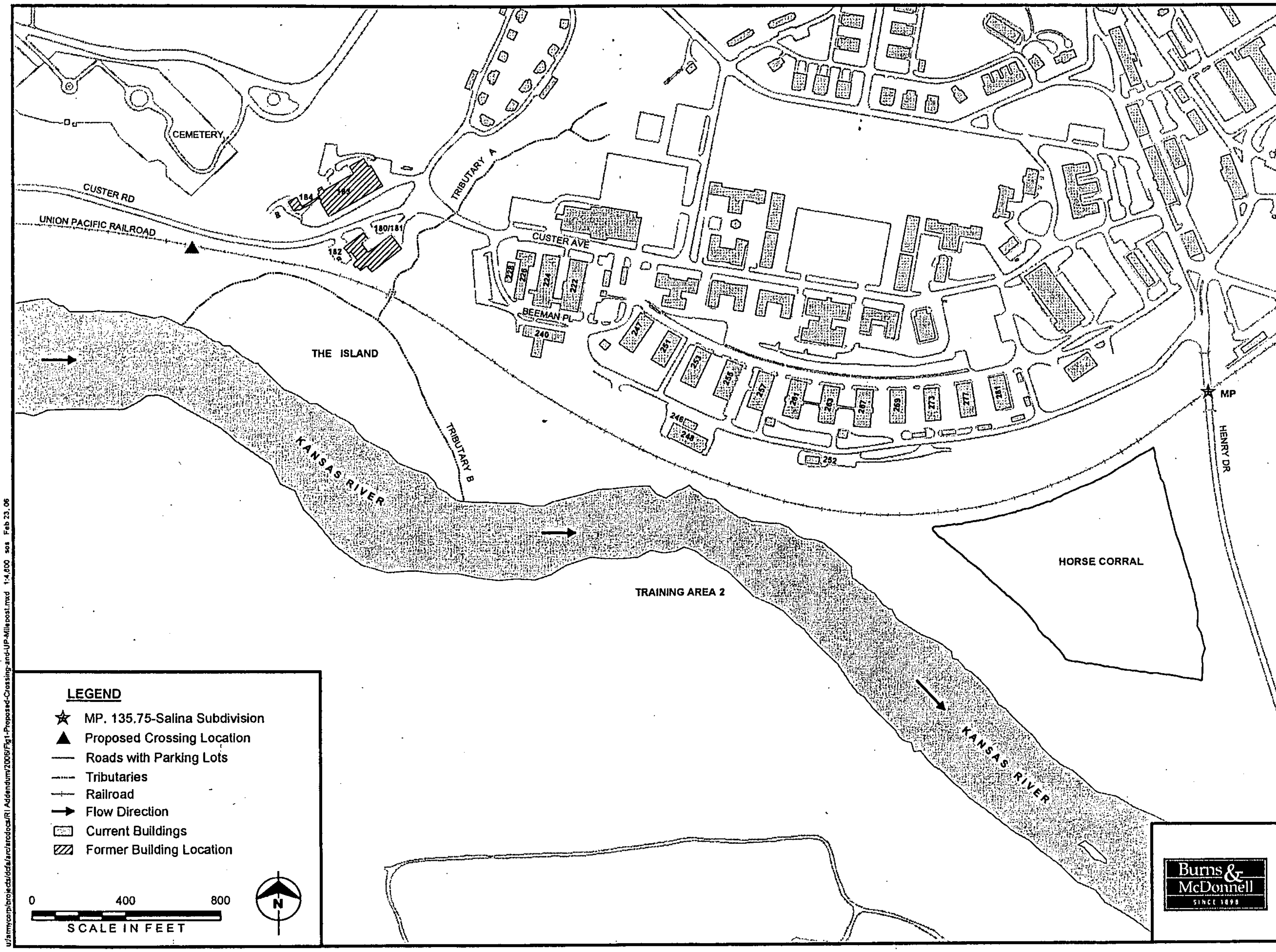
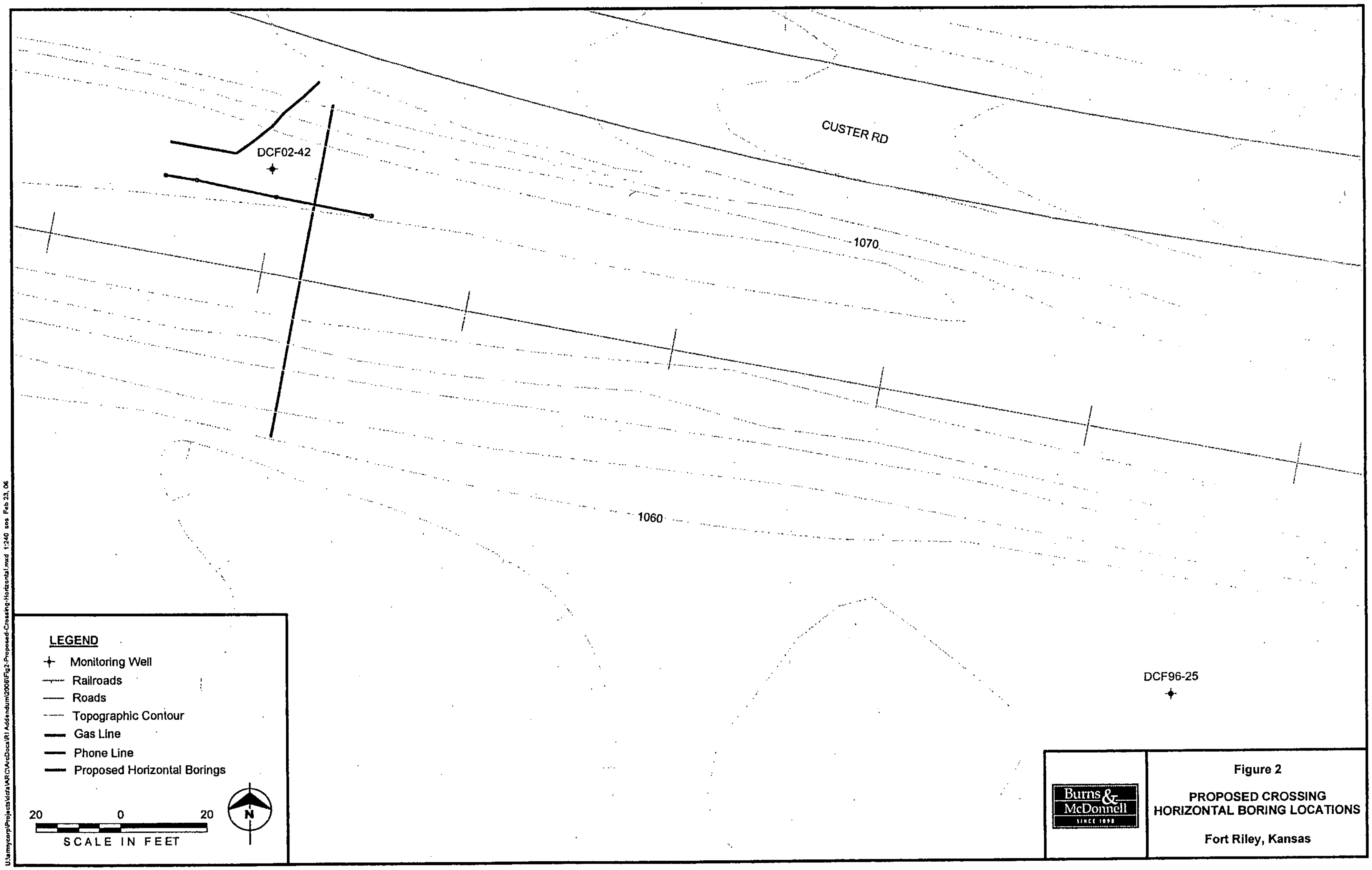


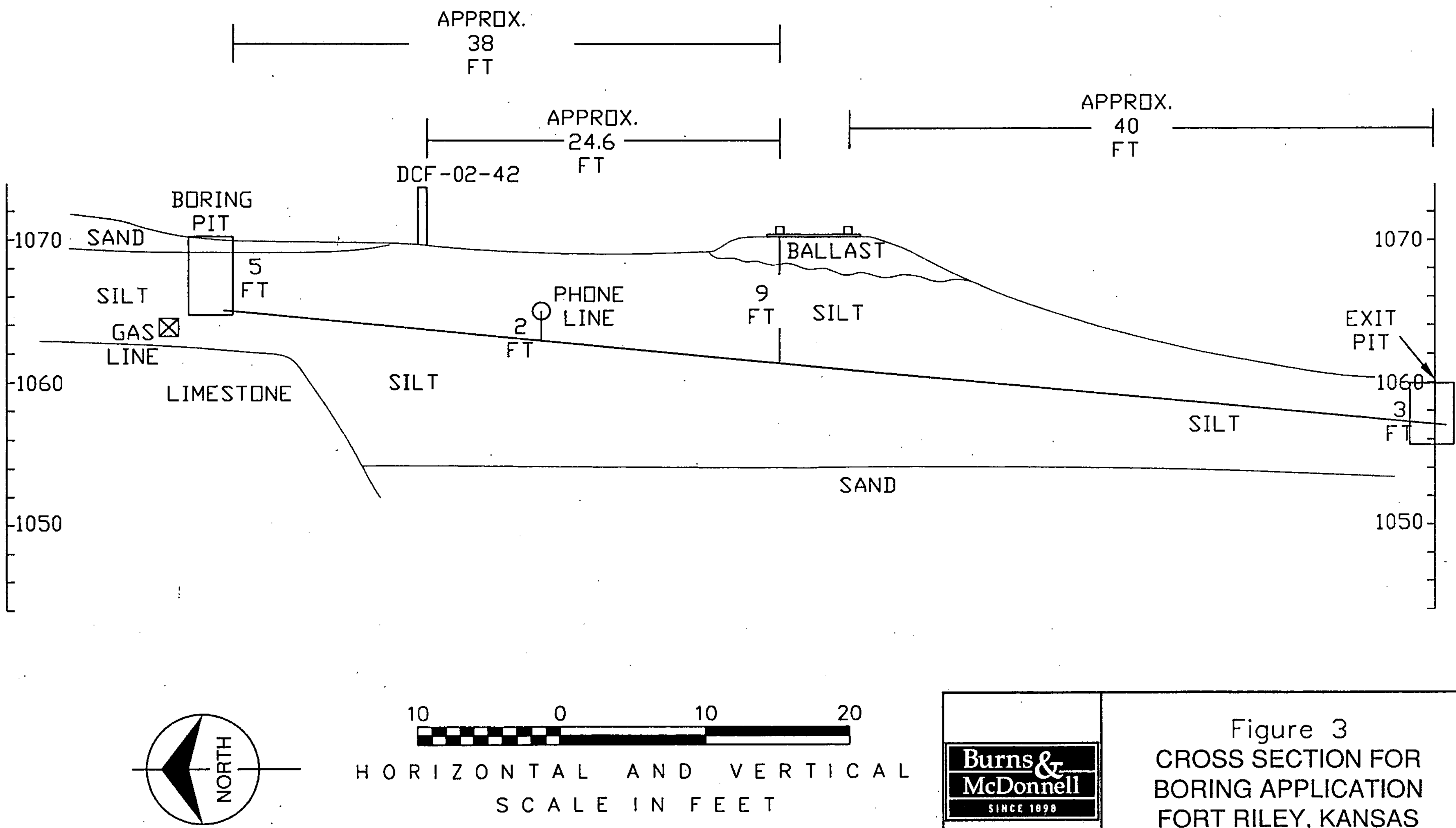
Figure 1

PROPOSED CROSSING AND UP MILEPOST

Fort Riley, Kansas

u:/armycorp/projects/dds/arc/arcdocs/RI Addendum/2006/Fig1-Proposed-Crossing-and-UP-Milepost.mxd 1:4,800 sos Feb 23, 06


CUSTER RD
DCF02-42
1070
1060
DCF96-25
LEGEND
Monitoring Well
Railroads
Roads
Topographic Contour
Gas Line
Phone Line
Proposed Horizontal Borings
20
0
20
SCALE IN FEET
N
Burns & McDonnell
SINCE 1898
Figure 2
PROPOSED CROSSING
HORIZONTAL BORING LOCATIONS
Fort Riley, Kansas



Burns & McDonnell
SINCE 1898

Figure 3
CROSS SECTION FOR
BORING APPLICATION
FORT RILEY, KANSAS

Boring Plan

M&D EXCAVATING

M & D of Hays, Inc. · P. O. Box 184 · Hays, KS 67601

785-628-3169 · Fax 785-625-6538

February 24, 2006

Burns & McDonnell
Fax# 636-326-8295

Dear Robert Downer:

Please find enclosed a copy of pipe specification provided to us by Frank Black in McPherson, KS. We recommend using .312 schedule 80 pipe, inside diameter 3.876 and weight 13.96 per foot.

M & D of Hays, Inc. has been in business since 1979. We are one of the largest boring businesses in Kansas and currently have 15,000 ft of boring jobs lined up. We have bored for Union Pacific several times in the past for Eagle Cable, Midwest Energy, and APAC of Kansas. We have drilled under various surfaces pulling back as thick as 36" steel. We bored 151ft of culvert under railroad track in July 2005 in Solomon, Kansas, for Union Pacific Railroad. We bore under the railroad track February 23, 2006 in Junction City on Fort Riley base.

We will be using a Ditch Witch 2720 bore unit to complete this job. The pilot bore is 4" and the back reamer 6". We will start in the ground with 24% down grade with a slight bend on pipe and at finish of bore we will be going down 10% so that the pipe will come out 40ft south of south rail at ground level. This will give us 9ft plus depth under north side of rail. We will have to hand dig to locate phone and gas to secure safety. We could locate lines with a pothole machine, a high pressure locating machine, which makes small hole to expose line, only considering the underground line is there. This method can be done at addition expenses. We will be 2 ft below AT & T phone line. The last option to locating underground lines is to spend a day prior to bore and hand dig to locate underground lines. We need one pit to disconnect 4" line at 38ft mark north of tracks approx. 5 ft deep. We would like to place all three bores with in a 3ft pit, allowing 1 ft separation. We will be using bentonite drilling mud to assist in the bore. The bentonite forms a clay base to pack tightly around pipe to prevent faults under ground. We will use approx. 200 gallons of water. The products removed will be replaced by pipe and all voids filled by bentonite. The estimated length of pipe needed for each bore is 87ft. We have designed it to be 2ft under phone lines approx. 6 ft in depth and 10ft under south rail.

Enclosed is a copy of our Certificate of Insurance. If you need any further information, please do not hesitate to contact us. We look forward to working with you.

Sincerely,
M & D of Hays, Inc.

Bethany Skinner

Bethany Skinner
Secretary

Liberty Mutual
Insurance Company

Liberty Mutual.
Liberty Mutual Insurance Group/Boston

RAILROAD PROTECTIVE
LIABILITY DECLARATIONS

ACCOUNT	SUB-ACCT. NO
43 28 88	0000

POLICY NO.	TD/CD	SALES OFFICE	CODE	SALES REPRESENTATIVE	CODE	N/R	1ST YR. LIAB. POL.
TE1- 141-432888-166	32/2	Overland Park, KS	0448	Mills	6196	1	2006

Item 1. Named Insured Union Pacific (UP)

Address 1400 Douglas St
Omaha, NE 68169

SALES OFFICE COPY

		Mo.	Day	Year		Mo.	Day	Year
Item 2. Policy Period:	From	3	15	2006	To	3	15	2007

12:01 A.M., standard time at the address of the named insured as stated herein.

Item 3. In return for the payment of the premium, and subject to all the terms of this policy, we agree with you to provide the insurance as stated in this policy.

LIMITS OF INSURANCE	
EACH OCCURRENCE LIMIT	$ 2,000,000
AGGREGATE LIMIT	$ 6,000,000

Item 4. Designated Contractor: Burns & McDonnell
Mailing Address: PO Box 419173
Kansas City, MO 64141

JOB LOCATION: Dry Cleaning Facilities Area (DCFA) at Fort Riley, KS

☒ Check here if the following provision is applicable:

The person or organization designated above as the Contractor has undertaken to pay the premium for this policy and shall be entitled to receive any return premiums and dividends, if any, which may become payable under the terms of this policy.

Item 5. NAME AND ADDRESS OF INVOLVED GOVERNMENTAL AUTHORITY OR OTHER CONTRACTING PARTY:
Union Pacific (UP)

Item 6. Designation of the Job Site and Description of Work:
Ft. Riley, KS

Classifications	Code No.	Premium Base Contract Cost	Rate Per $1,000 of Cost	Advance Premium Line Code 317
Railroad Protective M = $4,716	40007	Flat Charge		4,716
Terrorism Risk Insurance Act M = Minimum Premium				No Charge
		TOTAL ADVANCE PREMIUM		$ 4,716

Audit Basis: ☐ At Expiration, ☐ Annual, ☐ Semi-Annual, ☐ Quarterly, ☐ Monthly, ☒ Flat Charge

These declarations, together with the Common Policy Conditions, Coverage Form(s) and any endorsement(s), completed the above numbered policy.

Forms and endorsements attached to this policy: See attached forms and endorsements schedule

This policy, including all endorsements issued herewith, is hereby countersigned by ....
Authorized Representative

"N"9N00"

LOC. CODE	TYPED	PERIODIC PAYMENT	RATING BASIS	AUDIT BASIS	HOME STATE	POL. HG.	RENEWAL OF
1	PAH 2/2/06	$	☐ R ☒ NR	0	KS	3- ☐	New

GPO 4058 R1

Appendix C
Magnetometer Survey

COLOG
Borehole Geophysics & Hydrophysics
A Division of Layne Christensen Company

Midwest Region
PO Box 81864
Lincoln, Nebraska 68501
Tel/Fax: 402-466-5997

December 7, 2005

Mr. Walter McClendon
Burns & McDonnell
9400 Ward Parkway
Kansas City, Missouri 64114

Re: Magnetometer Survey
Fort Riley, Kansas

Dear Mr. McClendon:

This letter presents the results of magnetometer surveys completed at Fort Riley, Kansas. These surveys were carried out at the request of Burns & McDonnell as part of site remediation activities. The surveys were to provide information regarding the possible positions of abandoned underground pipelines and manholes. These pipelines are slated for excavation and removal.

Theory of Operation

A magnetometer measures the strength of the earth's magnetic field. The strength of the earth's magnetic field varies with location on the earth and with variation in subsurface rocks and minerals, primarily controlled by the amount of iron. The magnetic gradient is a measurement of the change in the strength of the magnetic field at two different elevations at the same point. Under natural conditions in an area with little variation in lithology and mineralogy, the magnetic field and gradient will be relatively consistent.

In a small area the background magnetic field and gradient will be relatively homogenous, and the presence of buried ferrous metal or fired clay will cause distortions in the field. By using two magnetometers oriented vertically in-line with one another, the strength of the magnetic field gradient can also be measured. A contour map of total field and gradient measurements collected on a grid reveals the location of magnetic anomalies.

A Geonics G-858 gradiometer was used for the survey. The gradiometer consisted of two magnetometers spaced 1.5 feet apart on a staff, with the upper unit six feet above ground. Each instrument measured total magnetic field, and the difference between the upper and lower readings was used to calculate the magnetic gradient.

Field Activities

1. The survey locations were identified and gridded by Burns & McDonnell. The survey areas were laid out on a 10-foot grid marked with wooden stakes. A corner of each survey area was arbitrarily designated as the start point 0N, 0E. Actual north-south directions were not determined as part of the survey, however site landmarks were noted for coordination of magnetometer plots with site surveys. Three separate surveys were completed.
2. A base station was located to measure background and check for instrument drift. Due to the excessive amount of noise from cultural features, the same base station was used for all three surveys.
3. The magnetometer surveys were conducted by traversing each survey area and recording instrument response on a data logger which kept track of station, upper and lower magnetometer readings, gradient, date, and time. Site features were also noted relative to the survey nodes (utilities, structures, etc.).
4. At the completion of data collection work the data were downloaded to a field computer for review. The data were observed to be complete.
5. The data were plotted and contoured using commercial software (Surfer (v7) from Golden Software) to identify anomalies in the readings.
6. Plots of total magnetic field and gradient were reviewed for interpretation of subsurface conditions.

Findings & Interpretation

Three areas were surveyed which were arbitrarily identified as Area 1, 2, and 3 for the purposes of this report. The background reading for the total magnetic field was 53,550 nanoTeslas (nT), and the average gradient was between 2.5 and 3.0 nT..

Area 1 was located on a hill and was 30 feet (E stations) by 100 feet (N stations). One corner of this area was covered with asphalt paving, while the rest was grass covered. A steam tunnel was present along one edge of the survey area. The purpose of the survey was to map a manhole location. The average total magnetic field in the survey area was 53,548 nT, and the average gradient was –9.3 nT. Both total field and gradient measurements were strongly affected by the steam tunnel. Two anomalies were identified in the gradient data that may represent a manhole location, these were centered at (70N, 10E) and (90N, 10E). The actual location may vary up to five feet from that identified by the survey. No pipeline was apparent in the data unless it is close to and parallel to the steam tunnel.

Area 2 was located along a roadway and measured 40 feet (N stations) by 200 feet (E stations). The goal of the survey in this area was to map an abandoned pipeline. Numerous cultural features were observed in this area, including a monitoring well complex, a telephone junction box, a water main, and a gas pipeline. The maximum total field measurement was 57,204 nT, the minimum was 52,099 nT, and the average was 53,857 nT. The magnetic gradient ranged from –720 to 488 nT, and averaged 1.4 nT. Both readings were highly variable across the site and were strongly influenced by cultural features. No linear anomalies were identified which could represent the location of a buried pipeline, however, several anomalies were noted in the data. Two were especially apparent in the gradient data at (30N, 70E) and (30N, 100E). In addition, a gradient dipole was observed in the gradient data along 10N between 80E and 180 E. Finally, the total field data exhibited strong variation from the background field in a large area from (0N, 80E) to (20N, 190E). A portion of this area is close to the water main shown on Figure 2.

Area 3 was located between a roadway and railroad tracks, and contained several cultural features including a monitor well pad, a guardrail and bollards, a buried gas line, and a buried fiber optic line. The area was 10 feet (N stations) by 90 feet (E stations). Total magnetic field measured here ranged from52472 to 55443 nT, and averaged 53577 nT. The magnetic gradient ranged from –237 to 409, and averaged 39.7 nT. An anomaly was observed in the gradient data along the 0N line between 35E and 70E.

Base maps of each survey area, along with total magnetic field and magnetic gradient contour maps are attached. Figures 1, 2, and 3 correspond to Areas 1, 2 and 3 respectively.

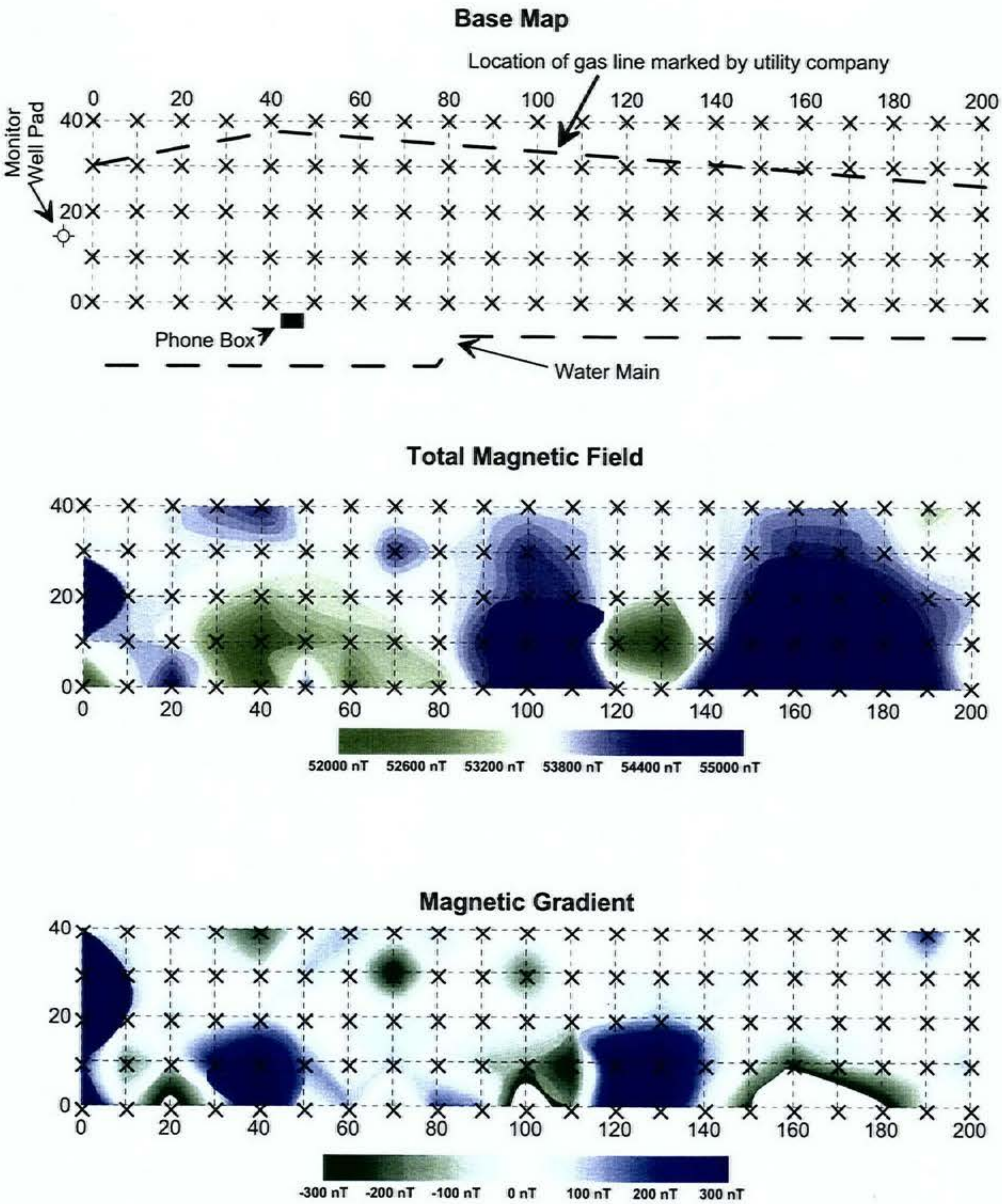
This geophysical survey was conducted according to generally accepted techniques and practices. The findings and interpretations are based on site information provided to Colog Division—Layne Christensen Company and information collected in the field. The findings and interpretations of this report should be reviewed and evaluated if additional site data are collected.

Please call me if you have any questions.

COLOG DIVISION
LAYNE CHRISTENSEN COMPANY

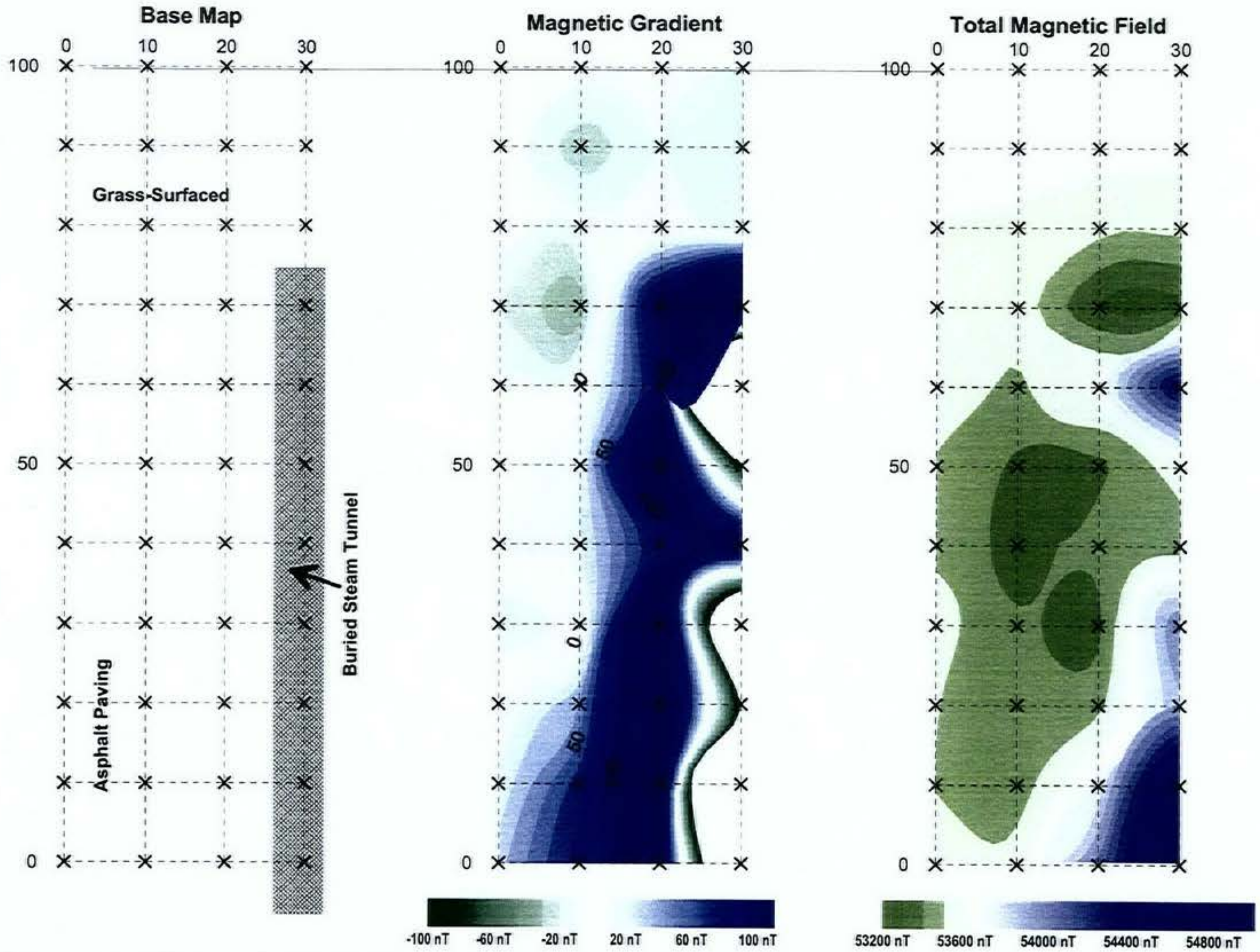
Mike Madcharo, PG

Attachments



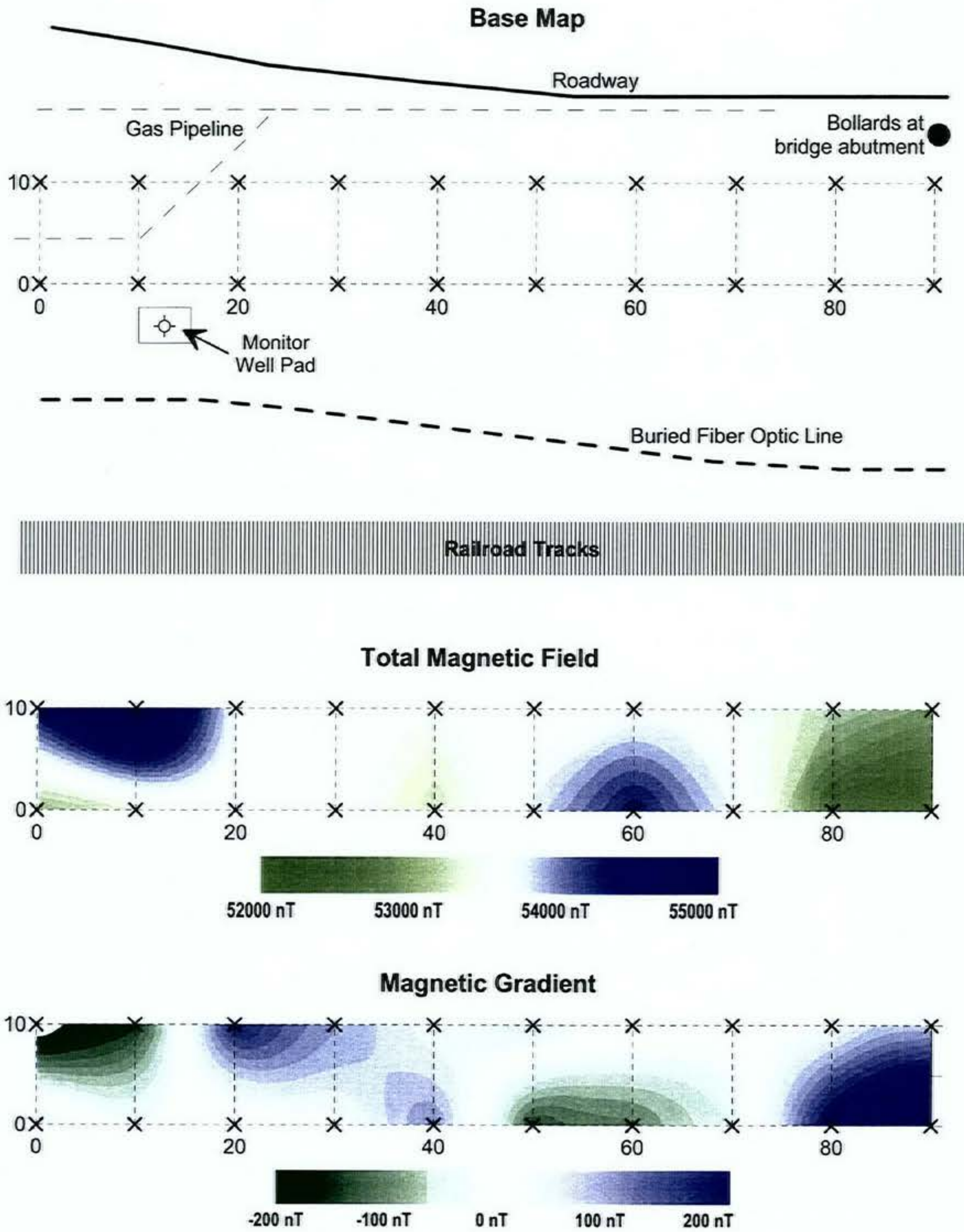
ECC / BURNS & McDONNELL
FORT RILEY, KANSAS

FIGURE 2: MAGNETOMETER SURVEY RESULTS AT AREA 2



ECC / BURNS & McDONNELL
FORT RILEY, KANSAS

FIGURE 1: MAGNETOMETER SURVEY RESULTS AT AREA 1



ECC / BURNS & McDONNELL FORT RILEY, KANSAS	FIGURE 3: MAGNETOMETER SURVEY RESULTS AT AREA 3

Appendix D
Monitoring Well Diagram & Field Form
DCF 06-40

Monitoring Well DCF 06-40

Project Number: 40904
Project Name: DCF Pilot Study
Monitoring Well No: DCF 06-40
Well Location: N14192967.9418 E2267389.2802
Installation Start (Date/Time): 01/30/06 (1133)
Completion (Date/Time): 01/31/06 (1135)

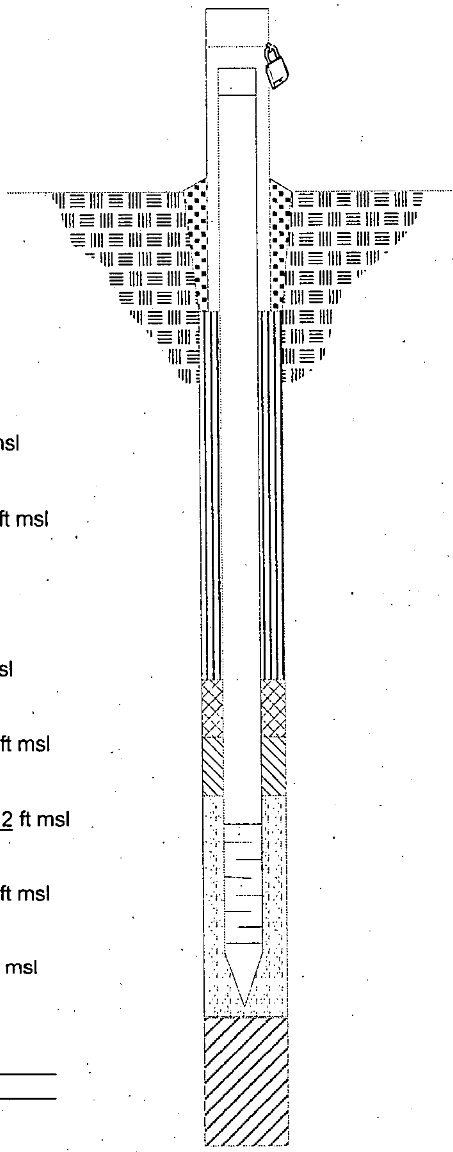
Well casing, top elevation 1087.90 ft. msl

Land surface elevation 1085.53 ft. msl

Top View

Side View

Sketch of Surface Completion



Annular seal, top 2.0 ft bgs / 1083.5 ft msl

Bentonite seal, top 27.8 ft bgs / 1057.7 ft msl

Fine sand, top NA ft bgs / 0.0 ft msl

Filter pack, top 31.8 ft bgs / 1053.7 ft msl

Screen joint, top 34.7 ft bTOC / 1053.2 ft msl

Bottom of end cap 44.7 ft bTOC / 1043.2 ft msl

Filter pack, bottom 44.7 ft bgs / 1040.8 ft msl

Borehole, bottom 44.7 ft bgs / 1040.8 ft msl

Development:
Method: Watterra Surge/Purge
Date: 02/02/2006

Static water level >24hr. after development

Date	Time	Level below TOC
03/27/06	1128	40.85
03/29/06	1045	40.80
10/02/06	1520	41.06

1. Cap and Lock? ☒Yes ☐No
2. Protective cover:
   a. Inside Diameter 3.5 in.
   b. Length 5.0 ft.
   c. Material STEEL
   d. Weep hole location/size: BOTTOM, 0.25-INCH
   e. Add. protection? ☒Yes ☐No
3. Pad type/dimensions: 3X3 SQUARE
4. Surface Seal: ☒ Concrete ☐ ____
5. Material between well casing and protective cover: SAND
6. Annular seal: ☐ Granular bentonite ☐ Bentonite slurry ☒ Bentonite-cement ☐ Other ____
7. Bentonite seal: ☐ Granular bentonite ☐ Bentonite pellets ____ inch ☒ Bentonite chips 3/8 inch ☐ Other ____
8. Fine sand: Manufacturer, name, & size NA
   Volume added NA lbs.
9. Filter pack: Manufacturer, name, & size Richmix #8 Silica Sand, 10/30
   Volume added 360 lbs
10. Well casing:
    Type Premium Perma Flow
    Manufacturer Aurora/Horizon
    Outside diameter 2.01 in.
    Inside diameter 1.99 in.
11. Screen material:
    Type Premium Perma Flow
    Manufacturer Aurora/Horizon
    Slot size 0.010 in.
    Outside diameter 2.01 in.
    Inside diameter 1.99 in.
12. Backfill material (below filter pack): ☒ None ☐ Other na
13. Centralizers: ☒ No ☐ Yes
    If yes, Type/material ____
    Number Installed within HSA
    Depth(s) ____

Comments Well installed to replace DCF 01-40

Driler: Geocore
Inspector: W. McClendon
Discrepancies:
Checked by: W McClendon **Date:** ____

Monitoring Well DCF06-40

Ground Surface
Northing – 14192967.9418
Easting – 2267389.2802
Elevation – 1085.53 MSL

Top of Casing
Northing – 14192967.3641
Easting – 2267389.6657
Elevation – 1087.90

Total Depth of Well
47.07 TOC
1040.83 Elevation

Top of Screen
34.49 TOC
1053.41 Elevation

Water Level
41.06 TOC October 2, 2006
1046.84 Elevation

Datum
Horizontal NAD 83 UTM, Zone 0014, U.S. Survey Feet
Vertical NAVD 88, U.S. Survey Feet

Well Development Form

Project Number: 40904	Well Number: DCF-06-40

Project Information	**Elevation of Well**
Facility Name: Dry cleaning Facility study Area	Ground Surface Elevation (GS): 1085.54
Location: N 14192967.9418 E 2267389.2802	Top of Casing Elevation (TOC): NA 1087.90

Well Information			
Date Well Installed:	January 30, 2006		
Total Depth of Well:	47.07	feet from	TOC
Depth to Top of Screen:	34.49	feet from	TOC
Length of Casing Screened:	10	feet	
Type of Formation Screened:			

Well Volume Calculation

1WV = 5.85 X 0.0408 X 4 = .95472 X 5 = 4.7736 gallons for 5 well volumes

1 well volume (gallons) = initial height of water column (ft) x 0.0408 x (casing diameter (in))2

Well Development Method

Equipment: WATERRA

Surge	✓	Bail	
Airlift		Pump	✓

Method Description: WILL SURGE & PURGE IN TWO FOOT SECTIONS (3 SECTIONS TOTAL) THEN PUMP UNTIL PARAMETERS STABILIZE & TURBIDITY IS LESS THAN 50 NTUs

Observations During Well Development

Date	Time	Depth to Water* (ft)	Total Depth* (ft)	Fluid Removed Gallons	Fluid Removed Total	Temp. (degrees F)	pH (units)	S.C. (S/cm)	Turbidity (NTU)	Fluid Appearance and Remarks (color, odor, etc.)
2/2/06	1410	41.25	47.10	–	–	68.1	7.3	1720	O.R.	SECOND 2' SECTION... NO WATER GENERATED ON FIRST SECTION
	1420			2.5	2.5	63.6	7.1	1620	O.R.	LAST 2' SECTION
	1430			2.5	5.0	62.6	7.3	1770	O.R.	
	1435			2.5	7.5	61.8	7.1	1680	O.R.	
	1439			2.5	10.0	61.7	7.1	1870	O.R.	
	1444			2.5	12.5	61.6	7.1	1890	O.R.	WELL DRY... WILL LET RECHARGE FOR 30 MIN THEN PUMP AGAIN
	1515			2.5	15.0	65.3	7.1	1880	O.R.	
	1525			2.5	17.5	61.5	7.1	1890	O.R.	WELL DRY AGAIN... WILL LET RECHARGE FOR 30 MIN THEN PUMP AGAIN
	1555			–	17.5	63.8	7.1	1890	O.R.	
	1600			2.5	20.0	63.1	7.1	1900	O.R.	
	1612			2.5	22.5	61.7	7.1	1890	O.R.	WATER CLEARING UP... STILL OVER RANGE
	1635			5.0	27.5	63.1	7.2	1880	O.R.	WELL NOT PRODUCING... GOING DRY FOR THIRD TIME
	1640	44.89	47.10	–	–	–	–	–	–	W/L TAKEN AFTER HOSE REMOVED... WELL SLOWLY RECOVERING
										Well considered developed after
										going dry 3 times.

* From TOC unless otherwise noted in Remarks

Burns & McDonnell SINCE 1898

051801 Form WCD-KC-6-1

Appendix E
Survey

2319 N. Jackson, PO Box 1304
Junction City, Kansas 66441
www.kveng.com

Tel: 785-762-5040
Fax: 785-762-7744
E-mail: JC@kveng.com

KV

KAW VALLEY ENGINEERING, INC.

Enviromental Chemical Corporation
Monitor Well & insertion Point Locations
Dry Cleaning Facility & Eagle Island Area

Datum:
Horizontal: NAD 83 UTM, Zone 0014, U.S. Survey Feet
Vertical: NAVD 88, U.S. Survey Feet

Well	Northing	Easting	Elevation
DCF 06-40	14192967.9418	2267389.2802	1085.53
Top of Casting	14192967.3641	2267389.6657	1087.90

Insertion Point	Northing	Easting	Elevation
EAB-1	14193076.0571	2267424.8850	1086.00
EAB-2	14193082.4129	2267436.2641	1086.19
EAB-3	14193097.3472	2267447.5205	1086.82
EAB-4	14193062.8696	2267422.9603	1085.65
EAB-5	14193056.5768	2267405.7514	1085.67
EAB-6	14193046.6984	2267422.5435	1085.44
EAB-7	14193038.8996	2267399.5673	1085.57
EAB-8	14193076.4374	2267477.7752	1086.79
EAB-9	14193083.6972	2267464.9654	1087.13
EAB-10	14193057.7623	2267473.9674	1086.35
EAB-11	14193075.9618	2267446.7245	1086.70
EAB-12	14193065.3790	2267462.7172	1086.72
EAB-13	14193057.4965	2267440.1298	1085.97
EAB-14	14193048.7137	2267455.3731	1086.42
EAB-15	14193039.6373	2267470.3310	1085.72
EAB-16	14193038.2555	2267435.8941	1085.62
EAB-17	14193031.4357	2267450.9662	1085.54
EAB-18	14193025.3223	2267468.2927	1085.52
EAB-19	14193006.0016	2267457.6597	1085.33
EAB-20	14193015.0589	2267445.8706	1085.11
EAB-21	14193022.3078	2267431.5253	1085.45
EAB-22	14193033.8700	2267413.2390	1085.57
EAB-23	14192990.4323	2267449.4731	1085.06
EAB-24	14192998.3859	2267437.2212	1085.74
EAB-25	14193005.2159	2267423.3066	1085.60
EAB-26	14193017.0763	2267406.8687	1085.16
EAB-27	14193023.8943	2267392.2690	1085.62
EAB-28	14193009.7817	2267386.5465	1085.74
EAB-29	14193000.7600	2267400.7134	1085.64
EAB-30	14192989.9840	2267413.9862	1085.51

other locations

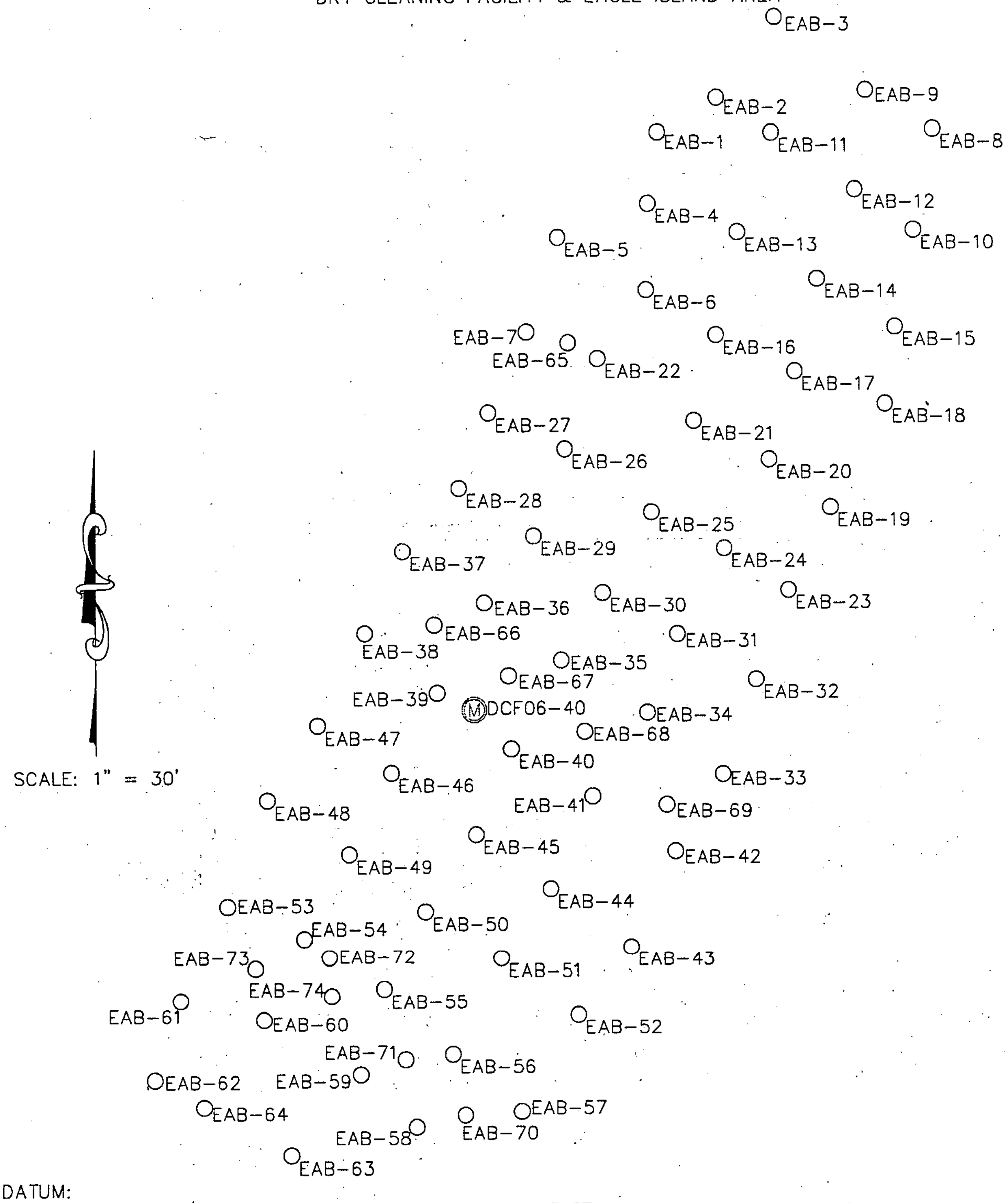
1333 N.E. Barry Road Kansas City, Missouri 64155 Tel: 816-468-5858 KC@kveng.com
14700 W. 114th Terrace Lenexa, Kansas 66215 Tel: 913-894-5150 LX@kveng.com

EAB-31	14192982.1301	2267428.1499	1085.58
EAB-32	14192973.5530	2267443.1400	1084.56
EAB-33	14192955.7340	2267436.7371	1083.81
EAB-34	14192967.3731	2267422.3419	1085.19
EAB-35	14192977.2394	2267405.9465	1085.18
EAB-36	14192988.1494	2267391.3900	1085.50
EAB-37	14192997.9318	2267375.7613	1085.68
EAB-38	14192982.3694	2267368.4731	1085.75
EAB-39	14192971.1072	2267382.2019	1085.39
EAB-40	14192960.5449	2267396.3338	1085.20
EAB-41	14192951.6121	2267411.8720	1084.66
EAB-42	14192941.2173	2267427.5694	1083.28
EAB-43	14192923.0595	2267419.0321	1082.43
EAB-44	14192934.0915	2267403.6524	1083.84
EAB-45	14192944.4154	2267389.5603	1084.92
EAB-46	14192956.0706	2267373.4250	1085.29
EAB-47	14192965.0054	2267359.2920	1085.50
EAB-48	14192950.9089	2267349.6365	1085.04
EAB-49	14192940.7132	2267365.3002	1085.19
EAB-50	14192929.8241	2267379.7698	1084.34
EAB-51	14192920.8876	2267394.2751	1083.46
EAB-52	14192910.0826	2267408.9788	1081.93
EAB-53	14192930.8469	2267341.9310	1084.55
EAB-54	14192924.6855	2267356.5237	1084.57
EAB-55	14192915.0203	2267371.8536	1083.43
EAB-56	14192902.6374	2267384.8961	1082.98
EAB-57	14192891.7664	2267398.0254	1081.52
EAB-58	14192888.8669	2267377.9834	1082.54
EAB-59	14192898.8018	2267367.3457	1082.96
EAB-60	14192909.1540	2267348.8473	1083.66
EAB-61	14192912.8387	2267332.8537	1083.80
EAB-62	14192897.8090	2267327.8401	1083.56
EAB-63	14192883.4911	2267353.9492	1083.14
EAB-64	14192892.6055	2267337.2351	1083.67
EAB-65	14193036.8474	2267407.6297	1085.31
EAB-66	14192983.9615	2267381.7047	1085.47
EAB-67	14192974.3276	2267395.8724	1085.35
EAB-68	14192963.8208	2267410.4197	1085.19
EAB-69	14192949.9914	2267425.9538	1083.95
EAB-70	14192891.1224	2267387.2525	1082.12
EAB-71	14192901.6267	2267375.9086	1083.23
EAB-72	14192921.0237	2267361.3578	1084.21
EAB-73	14192918.9057	2267347.2551	1083.98
EAB-74	14192913.6379	2267361.7758	1083.60

ENVIRONMENTAL CHEMICAL CORPORATION

MONITOR WELL & INSERTION POINT LOCATIONS

DRY CLEANING FACILITY & EAGLE ISLAND AREA



DATUM:
HORIZONTAL: NAD 83 UTM, ZONE 0014, U.S. SURVEY FEET
VERTICAL: NAVD 88, U.S. SURVEY FEET

P.O. BOX 1304
2319 NORTH JACKSON
JUNCTION CITY, KS 66441

785-762-5040
FAX 785-762-7744
E-MAIL jc@kveng.com

KAW VALLEY ENGINEERING, INC. - CONSULTING ENGINEERS

2319 N. Jackson, PO Box 1304
Junction City, Kansas 66441
www.kveng.com

Tel: 785-762-5040
Fax: 785-762-7744
E-mail: JC@kveng.com

KAW VALLEY ENGINEERING, INC.

Environmental Chemical Corporation
Monitor Well & Insertion Point Locations
Dry Cleaning Facility & Eagle Island Area

Datum:
Horizontal: NAD 83 UTM, Zone 0014, U.S. Survey Feet
Vertical: NAVD 88, U.S. Survey Feet

Well	Northing	Easting	Elevation
DCF06-40	14192967.9418	2267389.2802	1085.52
Top of Casing	14192967.3641	2267389.6657	1087.90
DCF02-42	14193034.6702	2266570.1504	1069.63

Insertion Point	Northing	Easting	Elevation
VI-1	14193038.7630	2266568.1389	1069.57
VI-2	14193040.3019	2266582.2517	1070.41
VI-3	14193035.6741	2266580.7806	1069.89
VI-4	14193029.5285	2266568.4533	1068.91
VI-5	14193035.6881	2266557.0816	1069.07
VI-6	14193041.5745	2266573.7253	1070.00
VI-7	14193032.9665	2266574.9983	1069.52
VI-8	14193037.0820	2266565.8290	1069.52
VI-9	14193040.7028	2266577.9266	1070.30
VI-10	14193027.9426	2266579.8741	1069.05
VI-11	14193035.6092	2266562.9290	1069.25
VI-12	14193032.3057	2266579.6087	1069.52
VI-13	14193033.2809	2266564.6514	1069.18
VI-14	14193038.9344	2266574.5808	1069.75
VI-15	14193028.4735	2266575.7051	1069.02
VI-16	14193036.4827	2266578.7727	1069.68
VI-17	14193030.8781	2266572.1122	1069.25
VI-18	14193034.0776	2266567.9660	1069.34
VI-19	14193036.8056	2266569.8928	1069.56
VI-20	14193033.8842	2266559.6406	1069.02
VI-21	14193031.0629	2266564.0507	1068.95
VI-22	14193037.8496	2266567.3709	1069.55
VI-23	14193036.8362	2266573.5768	1069.68

other locations

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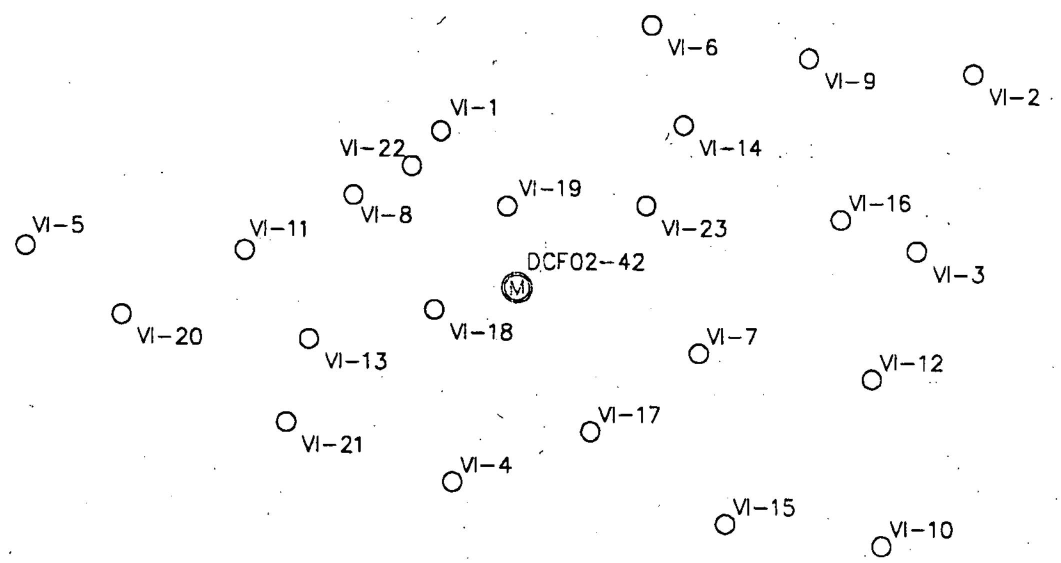
14700 W. 114th Terrace Lenexa, Kansas 66215 Tel: 913-894-5150 LX@kveng.com

ENVIRONMENTAL CHEMICAL CORPORATION
MONITOR WELL & INSERTION POINT LOCATIONS
DRY CLEANING FACILITY & EAGLE ISLAND AREA

SCALE: 1" = 5'



DATUM:
HORIZONTAL: NAD 83 UTM, ZONE 0014, U.S. SURVEY FEET
VERTICAL: NAVD 88, U.S. SURVEY FEET

P.O. BOX 1304
2319 NORTH JACKSON
JUNCTION CITY, KS 66441

785-762-5040
FAX 785-762-7744
E-MAIL jc@kveng.com
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CFN: 2515EXBA
DATE: MARCH 15, 2006

Appendix F
Vadose Zone Assessment Boring Logs
TS-1
TS-1a

HTW DRILLING LOG

HOLE NO.	TS-1
1. COMPANY NAME	Burns + McDonnell
2. DRILLING SUBCONTRACTOR	EPS
SHEET 1 OF 1 SHEETS	4
3. PROJECT	Dry cleaning Facilities Area
4. LOCATION	TS-1, near MWDCF02-42
5. NAME OF DRILLER	Pat Martin EPS
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Geoprobe GH-40 4 ft macrocore sample Acetate sleeves-2 inch Truck mounted Rig
8. HOLE LOCATION	DCFA, Near DCF02-42
9. SURFACE ELEVATION	Not measured
10. DATE STARTED	11/15/2005
11. DATE COMPLETED	11/15/2005
12. OVERBURDEN THICKNESS	28 feet
13. DEPTH DRILLED INTO ROCK	0
14. DEPTH OF HOLE	28 feet
15. DEPTH GOUNDWATER ENCOUNTERED	26
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	NA
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA
18. GEOTECHNICAL SAMPLES	NA; DISTURBED: NA; UNDISTURBED: NA
19. TOTAL NUMBER OF CORE BOXES	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
Yes - On-site Lab	PCE, TCE, Cis,1-2-DCE	NO	NO	NO	NO	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
✓	Bentonite	NA	NA	Walter B. McClendon

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	~~GEOTECH SAMPLE OR CORE BOX~~ NO. e GC	ANALYTICAL SAMPLE NO. f	~~BLOW COUNTS~~ Time	REMARKS h
Raining/sleet		Topsoil					Start Time 1015
	0–3	NO Recovery due to gravel and rock fragments. OFFset, same result.	NO Recovery				NO Recovery
	3	mottled clay, 7.5YR 5/4, brown, medium consistency, med plasticity, ~~moist~~ damp, with Rock fragments	2.2 0 2.0 0	6.3J —	314 551	1022	
	4		0				
	5	Same as above	0 —	—	—	—	

HTW DRILLING LOG

HOLE NO. TS-1

PROJECT DCFA | INSPECTOR Walter B. McClendon | SHEET 2 OF 4 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	~~GEOTECH SAMPLE OR CORE BOX NO.~~ GC e	ANALYTICAL SAMPLE NO. f	~~BLOW COUNTS~~ Time g	REMARKS h
	6	no Recovery due to gravel and rock fragments.		NO Recovery			NO Recovery Rocky
	7	silty clay, 5yr 4/4, brown damp, medium plasticity, medium consistency.	11.1				
			16.2	2.2J	7/8		
			2.2	—	SS2	1030	
	8						
	9		0				
				2.9J			
	10	same as above	0	—	SS3	—	
	11		0	<8.4			
	12	same as above	0	—	SS4	1037	
		Silt, 5y 7/2, yellowish gray clay to damp, soft consistency Trace plasticity					
	13		2.2				
	14		6.6	8.3J	SS5		
		same as above		—		—	

HTW DRILLING LOG

HOLE NO. TS-1

PROJECT DCFA | INSPECTOR Walter B. McClendon | SHEET 4 OF 3 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	~~GEOTECH SAMPLE OR CORE BOX~~ NO. GC e	ANALYTICAL SAMPLE NO. f	~~BLOW COUNTS~~ Time g	REMARKS h
		silt, 5Y 7/2, yellowish gray, dry to damp, soft consistency trace plasticity					
	15		2.2	~~2.2~~ <8.4			
		same as above	6.6	~~6.6~~	SS6	1052	
	16		2.2				
	17		6.6	31.3	16/18		
			2.2	–	SS7	–	
	18	same as above					
		silty sand 5Y 7/2, yellowish gray dry to damp, finegrained, well sorted, silt, soft consistency, trace plasticity	2.2				
	19		2.2	<8.4	18/20		
	20	same as above	6.6	–	SS8	1059	
	21		0	<8.4			
	22	same as above	0	–	SS9	–	
				20.4			
	23		0	–			
		same as above					

MRK FORM JUN 89 55-2 | PROJECT DCFA Pilot Study | HOLE NO. TS-1

HTW DRILLING LOG

PROJECT DLFA	INSPECTOR Walter B. McClendon	HOLE NO. TS-1	SHEET 4 OF 4 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	~~GEOTECH SAMPLE OR CORE BOX NO.~~ GC e	ANALYTICAL SAMPLE NO. f	~~BLOW COUNTS~~ Time	REMARKS h
	24	Silty Sand, 5Y 7/2, yellowish grey, dry to damp, fine grained, well sorted; silt, soft consistency trace plasticity	0		SS10	1105	
	25		6.6	12.3	24/26		
	26	Same as above	0		SS11		
		Silty clay, 5Y 3/2 Olive grey moist to wet, soft consistency highly plastic	—				No samples taken
	27	Sand, 10YR 7/4, greyish orange fine grained, well sorted, moist, rounded to subangular	—				
	28	silty Sand, 5Y 6/2 light Olive grey, wet, ~~sd~~ fine grained, well sorted; silt, trace plastic, soft consistency	—		SS12	1112	End Time 1125
		Bottom of Hole					Total Depth 28 ft
	29						
	30						
	31						
	32						

MRK FORM JUN 89 55-2 | PROJECT DLFA Pilot Study | HOLE NO. TS-1

TS-1a

HTW DRILLING LOG

HOLE NO.	TS-1a
1. COMPANY NAME	Burns & McDonnell
2. DRILLING SUBCONTRACTOR	EPS
SHEET 1 OF SHEETS	
3. PROJECT	PCFA Pilot Study
4. LOCATION	TS-1a, near DCF 02-42
5. NAME OF DRILLER	Pat Martin EPS
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe GH-40
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	4ft macrocore sampler; 2inch acetate sleeves; Truck mounted Rig
8. HOLE LOCATION	Fort Riley, Kansas
9. SURFACE ELEVATION	NM
10. DATE STARTED	11/16/2006
11. DATE COMPLETED	11/16/2006
12. OVERBURDEN THICKNESS	28 feet
13. DEPTH DRILLED INTO ROCK	0 feet
14. TOTAL DEPTH OF HOLE	28 feet
15. DEPTH GROUNDWATER ENCOUNTERED	@ 26 ft bgs
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
Pilot Treatability Study	NA	NA	Destruction	NOD	NA	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
✓	Bentonite	NA	NA	Walter B. McClendon

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e (Time)	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
	0–4	Multiple Offsets, Logging based on actual sample from multiple Locations.	NA	0938 ~~NA~~	SS1	NA	Start Time 0935 Discrete Sampling; no sample
	4–5	Clay, 7.5yr 5/4, brown, med. consistency, med plasticity, damp; with rock frags					Discrete

HTW DRILLING LOG

HOLE NO. TS-1a

PROJECT: DCFA Pilot Study | INSPECTOR: W B Mcclendon | SHEET 2 OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. Time	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
		Clay, 7.5yr 5/4, brown, med. consistency, med. plasticity, damp; with rock fragments					Discrete Sample 4/8
	6						
	7						
	8						NO Sample
	9						
	10						
	11		NA	0951	SS-2	NA	
	12	Silt, 5y 7/2, yellowish grey, dry to damp, soft consist, trace plasticity					Discrete 12/16
	13						
	14	Same as above					

HTW DRILLING LOG

HOLE NO. TS-1a

PROJECT: DCFA Pilot Study

INSPECTOR: W B McClendon

SHEET 3 OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. Time	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
		Silt, 5Y 7/2, yellowish grey, dry to damp, soft consist, trace plasticity					Discrete 12/16
	15						
	16						
	17						
	18						NO Sample
	19						
	20		NA	1010	SS3	NA	
		Silty Sand, 5Y/2, yellowish gray, dry to damp, fine grained, well sorted; silt, 5Y/2, yellowish gray, soft consistency, trace plasticity					Discrete 20/24
	21						
	22						
	23	Same as above					

051601
Form MRK-55-2

PROJECT: DCFA Pilot Study

HOLE NO. TS-1a

HTW DRILLING LOG

HOLE NO. TS-1a

PROJECT DCFA Pilot Study	INSPECTOR W. B. McClendon	SHEET 4 OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. Time	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
		Silty Sand, 5Y/2, yellowish gray, dry to damp, fine grained well sorted; silt, 5Y/2, yellowish gray, soft consistency, trace plasticity.					Discrete 20/24
	24						
	25						NO sample
	26	silty clay to silty sand, wet 5Y 3/2 olive grey to 10Y 7/4 greyish orange, soft consist highly plastic to fine grained well sorted					Discrete Sat. sample 26/28
	27						
	28	same as above	NA	1033	554	NA	
		Bottom of Hole					Total Depth 28 ft End Time 1044
	29						
	30						
	31						
	32						

Appendix G
Post Performance Monitoring Forms

July 2006

FIELD GROUND-WATER SAMPLING REPORT

\TE: 7/24/06 SITE: DCFA PID READING at WELL HEAD (ppm): –

PROJECT NUMBER: 40904 WEATHER: Clear 90's

WELL NUMBER: DCFA 92-05 DEPTH TO WATER (ft): –

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = ________ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1630±		300	6.48	13.55	1.542	245	-75.8	2.85	
1632.5		300	5.96	13.06	1.393	197	-59.5	2.14	
1635		300	5.59	12.73	1.401	118	-44.0	2.85	
1637.5		300	5.65	12.96	1.396	55.8	-42.5	3.90	
1640		300	5.73	12.99	1.397	22.2	-41.0	3.70	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.6 Total Iron = 0.6

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: – SAMPLE ID FOR QC: –

PARAMETERS REQUESTED FOR ANALYSIS: –

IDW TOTAL: ________ Flow through cell model number.: 556

	NAME	SIGNATURE	DATE
PREPARED:	Lewis Turner	[signature]	7/24/06

REVIEWED:

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/24/06 SITE: DCFA PID READING at WELL HEAD (ppm): –

PROJECT NUMBER: 40904 WEATHER: Clear 90's

WELL NUMBER DEPTH TO WATER (ft): –

DCFA93-13

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: ~~Dedicated Bladder Pump~~ Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1555 I		100	6.70	18.09	1.767	OR	18.1	6.01	
1557.5		100	6.22	17.60	1.751	21.6	33.5	6.29	
1600		200	6.14	17.45	1.709	44.8	-11.5	5.42	
1602.5		200	6.15	17.60	1.615	50.9	-47.5	4.14	
1605		200	6.17	17.73	1.554	33.9	-66.5	3.30	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 3.0 TI=4.0

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: – SAMPLE ID FOR QC: –

PARAMETERS REQUESTED FOR ANALYSIS: –

IDW TOTAL: ______ Flow through cell model number.: 556

	NAME	SIGNATURE	DATE
PREPARED:	Lewis Turner	[signature]	7/24/06
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/24/06 SITE: DCFA PID READING at WELL HEAD (ppm): –

PROJECT NUMBER: 40904 WEATHER: Clear 90's

WELL NUMBER: DCFA 0241 DEPTH TO WATER (ft): –

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1845 I		300	6.78	14.19	1.360	107	-20.0	2.67	—
1847.5		300	6.69	13.90	1.361	57.9	-35.7	1.84	—
1850		300	6.64	13.83	1.361	16.5	-44.8	1.57	—
1852.5		300	6.66	13.84	1.361	10.8	-51.2	1.45	—
1855		300	6.67	13.84	1.360	6.78	-59.1	1.37	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 7.0 Total Iron 8.0

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: – SAMPLE ID FOR QC: –

PARAMETERS REQUESTED FOR ANALYSIS: –

IDW TOTAL: ____ Flow through cell model number.: 556

	NAME	SIGNATURE	DATE
PREPARED:	Lewis Turner	[signature]	7/24/06
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/24/06 SITE: DFA PID READING at WELL HEAD (ppm): –

PROJECT NUMBER: 40904 WEATHER: Clear 90's

WELL NUMBER: DFA 06-40 DEPTH TO WATER (ft): –

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1755 I		200	6.79	20.80	1.692	523	28.6	2.74	
1757.5		200	6.16	17.49	1.618	120	51.2	2.51	
1800		200	6.25	17.35	1.627	34.2	46.4	2.41	
1802.5		200	6.31	17.39	1.632	20.9	41.7	2.18	
1805		200	6.31	17.27	1.633	13.8	40.1	2.08	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mS/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.1 Total Iron 0.1

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: – SAMPLE ID FOR QC: –

PARAMETERS REQUESTED FOR ANALYSIS: –

IDW TOTAL: ________ Flow through cell model number.: 556

	NAME	SIGNATURE	DATE
PREPARED:	Lewis Turner	[signature]	7/24/06
REVIEWED:			

August 2006

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

.OJECT NUMBER: 40904 WEATHER: ______

WELL NUMBER

DCF 92-05

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1105		200	6.45	15.05	1.366		38.8	~~5.5~~ ~~7~~5.57	—
1107:30		200	6.66	14.60	1.346		1.1	2.89	—
1110		200	6.79	14.35	1.323		-21.9	2.08	—
1112:30		200	6.80	14.40	1.319		-29.3	2.26	—
1115		200	6.81	14.45	1.321		-31.9	1.97	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

FERROUS IRON (mg/L): 0.6 VOC pH: ______ IDW TOTAL: ______

Total Iron: 1.0

DO METER MODEL No.: ______ ORP METER MODEL No.: ______

DO IN AIR: ______ DO IN ZERO OXYGEN SOLUTION.: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 08/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): ____

PROJECT NUMBER: 40904 WEATHER: ____

WELL NUMBER

DCF 93-13

DEPTH TO WATER (ft): ____

TOTAL DEPTH (ft): ____ WELL DIAMETER (inches): ____

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1042		300	6.63	15.44	1.352		-26.7	2.90	
1044.5		300	6.91	15.10	1.241		-77.3	1.00	
1047		300	7.00	14.98	1.212		-97.8	0.63	
1049.5		300	7.03	14.91	1.206		-107.5	0.47	
1052		300	7.04	14.90	1.206		-113.4	0.40	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FINAL DEPTH TO WATER (ft TOC): ____ TIME FINAL DEPTH TAKEN: ____

SAMPLE ID: ____ SAMPLE ID FOR QC: ____

PARAMETERS REQUESTED FOR ANALYSIS: ____

FERROUS IRON (mg/L): 7.0 VOC pH: ____ IDW TOTAL: ____

TOTAL IRON (mg/L): 8.0

DO METER MODEL No.: ____ ORP METER MODEL No.: ____

DO IN AIR: ____ DO IN ZERO OXYGEN SOLUTION.: ____

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ____

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

OJECT NUMBER: 40904 WEATHER: ______

WELL NUMBER

DEPTH TO WATER (ft): ______

DCF 02-41

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____gallons/ foot = ____total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1152	—	200	6.52	16.89	1.356	—	92.4	0.15	—
1154:30	—	200	6.99	15.00	1.330	—	-44.7	1.21	—
1157	—	200	7.01	14.90	1.322	—	-66.3	1.10	—
1159:30	—	200	7.03	14.90	1.320	—	-68.4	1.09	—
1202	—	200	7.04	14.84	1.319	—	-70.8	1.08	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

FERROUS IRON (mg/L): 5.0 VOC pH: ______ IDW TOTAL: ______

TOTAL IRON (mg/L): 7.0

DO METER MODEL No.: ______ ORP METER MODEL No.: ______

DO IN AIR: ______ DO IN ZERO OXYGEN SOLUTION.: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

PROJECT NUMBER: 40904 WEATHER: ______

WELL NUMBER

DCF-06-40

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ____ ft of water X ____gallons/ = ____total gallons/casing volume
in casing foot

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1125		200	6.83	21.28	1.824	—	38.9	2.16	—
1127:30		200	6.84	20.60	1.802	—	41.8	1.50	—
1130		200	6.85	20.34	1.790	—	42.9	1.28	—
1132:30		200	6.85	20.15	1.783	—	42.7	1.16	—
1135		200	6.86	20.15	1.780	—	41.8	1.10	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

FERROUS IRON (mg/L): 0 VOC pH: ______ IDW TOTAL: ______

TOTAL IRON (mg/L): 0.3

DO METER MODEL No.: ______ ORP METER MODEL No.: ______

DO IN AIR: ______ DO IN ZERO OXYGEN SOLUTION.: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

September 2006

FIELD GROUND-WATER SAMPLING REPORT

DATE: 09/05/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

PROJECT NUMBER: WEATHER: ______

WELL NUMBER

DCF 92-05

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1555		300	6.52	17.77	1.655	5.46	-27.8	7.59	—
1557:30		300	6.28	14.81	1.716	6.38	-59.1	2.55	—
1600		300	6.32	14.43	1.726	9.83	-94.0	1.69	—
1602:30		300	6.30	14.26	1.721	6.68	-124.2	1.58	—
1605		300	6.33	14.19	1.720	4.63	-136.3	1.73	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.1 IDW TOTAL: ______ TOTAL IRON (mg/L): 0.2

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

DO METER MODEL No.: ______ ORP METER MODEL No.: ______ FLOW CELL TYPE.: ______

DO CHECK IN AIR: Before: After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 09/05/06 SITE: DCFA PID READING at WELL HEAD (ppm): ________

PROJECT NUMBER: WEATHER: ________________

WELL NUMBER

DCF 93-13

DEPTH TO WATER (ft): ________

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): ________

PURGING

CASING VOLUME CALCULATION: _____ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1618		350	6.09	16.04	1.473	9.25	-24.4	6.46	—
1620:30		350	6.20	15.22	1.562	4.49	-220.4	2.58	—
1623		350	6.34	15.07	1.639	3.07	-241.8	1.04	—
1625:30		350	6.39	14.98	1.653	1.93	-254.1	0.67	—
1628		350	6.43	14.83	1.634	1.13	-261.3	0.53	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 2.0 IDW TOTAL: ________ Total Iron (mg/L): 3.0

FINAL DEPTH TO WATER (ft TOC): ________ TIME FINAL DEPTH TAKEN: ________

SAMPLE ID: ________ SAMPLE ID FOR QC: ________

PARAMETERS REQUESTED FOR ANALYSIS: ________

DO METER MODEL No.: ________ ORP METER MODEL No.: ________ FLOW CELL TYPE.: ________

DO CHECK IN AIR: Before: After: ________

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWER:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 09/05/06 SITE: DCFA PID READING at WELL HEAD (ppm): ________

PROJECT NUMBER: WEATHER: ________

WELL NUMBER

DCF 02-41

DEPTH TO WATER (ft): ________

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): ________

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = ________ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1457		300	6.43	17.6	1.615	44.8	59.8	7.05	—
1459:30		300	6.80	15.46	1.609	71.0	-2.4	3.00	
1502		300	7.01	15.03	1.608	68.1	-41.9	1.45	—
1504:30		300	6.86	14.81	1.598	40.5	-82.7	0.76	—
1507		300	6.90	14.75	1.597	27.2	-91.9	0.67	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 5.0 IDW TOTAL: ________ Total Iron 6.0 mg/L

FINAL DEPTH TO WATER (ft TOC): ________ TIME FINAL DEPTH TAKEN: ________

SAMPLE ID: ________ SAMPLE ID FOR QC: ________

PARAMETERS REQUESTED FOR ANALYSIS: ________

DO METER MODEL No.: ________ ORP METER MODEL No.: ________ FLOW CELL TYPE.: ________

DO CHECK IN AIR: Before: ________ After: ________

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 09/05/06 SITE: DCFA PID READING at WELL HEAD (ppm): ________

PROJECT NUMBER: WEATHER: ________

WELL NUMBER

DCF 06-40

DEPTH TO WATER (ft): ________

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): ________

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = ________ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1531		175	6.72	20.90	1.944	22.0	-46.0	3.25	—
1533:30		200	6.69	18.80	1.955	19.1	-77.1	2.41	—
1536		200	6.62	18.30	1.963	16.5	-82.1	2.20	—
1538:30		200	6.57	17.93	1.946	11.3	-88.8	1.71	—
1541		200	6.51	17.61	1.954	6.30	-91.1	1.49	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.0 IDW TOTAL: ________ Total Iron: 0.1 mg/L

FINAL DEPTH TO WATER (ft TOC): ________ TIME FINAL DEPTH TAKEN: ________

SAMPLE ID: ________ SAMPLE ID FOR QC: ________

PARAMETERS REQUESTED FOR ANALYSIS: ________

DO METER MODEL No.: ________ ORP METER MODEL No.: ________ FLOW CELL TYPE.: ________

DO CHECK IN AIR: Before: After: ________

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

NAME SIGNATURE DATE

PREPARED: ________ ________ ________

REVIEWED:

October 2006

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/2/06 SITE: Dry Cleaning Facility Area PID READING at WELL HEAD (ppm): 0.0

ROJECT NUMBER: 40904-3.20.20 WEATHER: Clear, sunny, 80's

WELL NUMBER: DCF92-05

DEPTH TO WATER (ft): 34.35

TOTAL DEPTH (ft): 41.77 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1533	I	125	6.93	16.37	1.803	2.64	105.5	7.28	34.51
1538	0.12	125	6.62	16.40	1.791	6.33	68.1	4.28	34.55
1543	0.24	125	6.65	16.36	1.777	7.84	41.7	3.37	34.57
1548	0.36	125	6.59	16.14	1.773	8.55	31.4	4.02	34.58
1553	0.48	125	6.59	16.04	1.777	7.16	17.7	3.64	34.58
1558	0.60	125	6.64	15.83	1.779	4.01	-25.8	3.61	34.58
1603	0.72	125	6.77	15.67	1.777	2.72	-47.3	3.55	34.58
1608	0.84	125	6.83	15.64	1.774	2.08	-58.4	3.51	34.58
1612	1.00	125	6.87	15.63	1.773	1.71	-64.1	3.47	34.58
1617	1.12	125	6.89	15.61	1.772	1.11	-66.1	3.48	34.58

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above. Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1620	1.12	6.89	15.61	1.772	1.11	-66.1	3.48	34.58	clear

FERROUS IRON (mg/L): 0.18 mg/L IDW TOTAL: 1.12

FINAL DEPTH TO WATER (ft TOC): 34.58 TIME FINAL DEPTH TAKEN: 1636

SAMPLE ID: DCF92-05 SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: TCL Volatiles, MEE, TOC, Alk, Cl⁻, SO_4, SO_3, NO_3, & Magnesium

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: 102.1 After: 101.7

HECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: YSI 556 MPS

	NAME	SIGNATURE	DATE
PREPARED:	Justin Cohen	[signature]	10/2/06
REVIEWED:			

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/3/06 SITE: Dry Cleaning Facility Area PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: 40904-3.20.20 WEATHER: clear, sunny, high 80's

WELL NUMBER: DCF93-13

DEPTH TO WATER (ft): 37.16

TOTAL DEPTH (ft): 41.66 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1149	I	175	6.73	17.84	1.813	10.3	-30.1	7.65	BTOP
1154	0.19	150	6.75	16.90	1.890	6.43	-87.5	3.45	BTOP
1159	0.32	150	6.79	16.78	1.879	5.32	-119.7	2.66	BTOP
1204	0.50	150	6.81	17.00	1.846	3.03	-132.1	2.58	BTOP
1209	0.65	150	6.83	17.03	1.847	2.52	-130.7	2.64	BTOP
1214	0.80	150	6.83	17.10	1.850	2.15	-132.1	2.57	BTOP

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1220	0.80	6.83	17.10	1.850	2.15	-132.1	2.57	BTOP	Clear

FERROUS IRON (mg/L): 0.03 mg/L IDW TOTAL: 0.80

FINAL DEPTH TO WATER (ft TOC): BTOP TIME FINAL DEPTH TAKEN: 1233

SAMPLE ID: DCF93-13/01 SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: TCL VOC, MEE, TOC, Alk, Cl⁻, NO_3, SO_3, SO_4 + Magnesium

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: 100.7 After: 100.9

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: YSI 556 MPS

	NAME	SIGNATURE	DATE
PREPARED:	Justin Coker	[signature]	10/3/06
REVIEWED:			

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/6/06 SITE: Dry Cleaning Facility Area PID READING at WELL HEAD (ppm): 0.0

ROJECT NUMBER: 40904-3.20.20 WEATHER: Clear, sunny low 70's

WELL NUMBER: DCF06-25

DEPTH TO WATER (ft): 22.22

TOTAL DEPTH (ft): 30.98 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
0933	1	Water turned purple instantly, no spent permanganate, 0.25 gallons removed							

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other No sample taken

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	—	—	—	—	—	—	—	—	—

FERROUS IRON (mg/L): NA IDW TOTAL: NA

FINAL DEPTH TO WATER (ft TOC): 22.24 TIME FINAL DEPTH TAKEN: 0934

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: NA

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: NA After: NA

HECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: NA

	NAME	SIGNATURE	DATE
PREPARED:	Justin Carler	[signature]	10/6/06
REVIEWED:			

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/4/06 SITE: Dry Cleaning Facility Area PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: 40904-3.20.20 WEATHER: Overcast, 70's, still

WELL NUMBER: DCF02-41

DEPTH TO WATER (ft): 20.37

TOTAL DEPTH (ft): 33.80 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
0743	I	250	6.56	16.39	1.687	15.2	85.5	7.32	20.75
0748	0.25	200	6.34	14.96	1.699	17.6	5.4	2.75	20.78
0753	0.45	200	6.65	14.63	1.691	12.0	-55.6	0.81	20.86
0758	0.60	150	6.77	14.75	1.690	9.18	-65.6	0.59	20.71
0803	0.75	150	6.80	14.77	1.694	7.21	-67.0	0.48	20.75
0808	0.90	150	6.82	14.75	1.697	5.63	-69.1	0.39	20.76
0813	1.05	150	6.82	14.74	1.699	3.94	-70.1	0.32	20.76
0818	1.20	150	6.84	14.75	1.700	3.06	-71.4	0.30	20.76

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
0820	1.20	6.84	14.75	1.700	3.06	-71.4	0.30	20.76	Clear

FERROUS IRON (mg/L): 3.11 mg/L IDW TOTAL: 1.20

FINAL DEPTH TO WATER (ft TOC): 20.79 TIME FINAL DEPTH TAKEN: 0900

SAMPLE ID: DCF02-41 SAMPLE ID FOR QC: DCF02-41/11 + DCF02-41/01QA ~~TCL VOC, TOC, MEE~~

PARAMETERS REQUESTED FOR ANALYSIS: TCL VOC, MEE, TOC, Alk, Cl, NO3, SO3, SO4, Magnesium

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: 100.7 After: 100.0

CHECKED FLOW THROUGH CELL FOR LEAKS: [X] COMMENTS: YSI 556 MPS

	NAME	SIGNATURE	DATE
PREPARED:	Justin Carter	[signature]	10/4/06
REVIEWED:			

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/6/06 SITE: **Dry Cleaning Facility Area** PID READING at WELL HEAD (ppm): 0.0

ROJECT NUMBER: 40904-3.20.20 WEATHER: Clear, sunny, low 70's

WELL NUMBER: DCF02-42

DEPTH TO WATER (ft): 32.65

TOTAL DEPTH (ft): 33.17 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
0818	1st bail	Redish brown		5" of H_2O					
0819	2nd bail	Deep purple w/tint of brown			3" of H_2O				
0820	3rd bail	Deep purple w/tint of brown			2" of H_2O				
0821	4th bail	Deep purple w/tint of brown			2" of H_2O				
0822	5th bail	Deep purple 3" of H_2O							
0823	6th bail	Deep purple 2" of H_2O							
0824	7 ~~6~~th bail	Deep purple 4" of H_2O							
0825	8th bail	Deep purple 3" of H_2O							
26	9th bail	Deep purple 1" of H_2O							
0827	10th bail	Deep purple <1" of H_2O							

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other Not sampled

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	—	—	—	—	—	—	—	—	—

FERROUS IRON (mg/L): NA IDW TOTAL: ~0.13

FINAL DEPTH TO WATER (ft TOC): NA TIME FINAL DEPTH TAKEN: NA

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: NA

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: NA After: NA

HECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:	Justin Carter	[signature]	10/6/06
REVIEWED:			

Pilot Study Well

FIELD GROUND-WATER SAMPLING REPORT

DATE: 10/3/06 SITE: Dry Cleaning Facility Area PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: 40904-3.20.20 WEATHER: clear, sunny, 80's

WELL NUMBER: DCF06-40

DEPTH TO WATER (ft): 41.22

TOTAL DEPTH (ft): 47.40 WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1035	I	150	6.60	20.55	2.084	3.10	120.8	2.88	41.26
1043	0.15	150	6.61	18.53	2.083	2.96	111.5	1.98	41.27
1048	0.30	150	6.73	17.73	2.077	2.82	91.6	1.61	41.31
1053	0.45	150	6.76	17.65	2.072	1.89	79.3	1.49	41.33
1058	0.60	150	6.77	17.66	2.070	1.11	70.3	1.32	41.33
1103	0.75	150	6.78	17.70	2.071	1.02	66.8	1.29	41.33
1108	0.90	150	6.77	17.78	2.068	0.95	59.2	1.33	41.33
1113	1.05	150	6.78	17.94	2.067	0.38	57.1	1.26	41.33

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1115	1.05	6.78	17.94	2067	0.38	57.1	1.26	41.33	clear

FERROUS IRON (mg/L): 0.56 mg/L IDW TOTAL: 1.05

FINAL DEPTH TO WATER (ft TOC): 41.33 TIME FINAL DEPTH TAKEN: 1140

SAMPLE ID: DCF06-40/01 SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: TCL VOC, MEE, TOC, Alk, NO_3, Cl, ~~[illegible]~~ SO_3, SO_4, Magnesium

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

DO CHECK IN AIR: Before: 101.2 After: 100.7

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: YSI 556 MPS

	NAME	SIGNATURE	DATE
PREPARED:	Justin Carter	[signature]	10/3/06
REVIEWED:			

November 2006

FIELD GROUNDWATER SAMPLING REPORT

DATE: 11/06/06 SITE: DCFA PID READING at WELL HEAD (ppm): ________

ROJECT NUMBER: 40904 WEATHER: ________

WELL NUMBER

DCF 93-13

DEPTH TO WATER (ft): 36.85

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): ________

PURGING

CASING VOLUME CALCULATION: _____ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1512:30		300	6.40	14.85	1.741		-194.6	4.75	
1515		300	6.59	14.44	1.906		-223.1	2.74	
1517:30		300	6.68	14.30	1.903		-219.3	3.63	
1520		300	6.72	14.24	1.871		-231.9	3.99	
1522:30		300	6.75	14.21	1.834		-242.2	3.32	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.1 TOTAL IRON (mg/L): ~~IDW TOTAL~~: 0.2

FINAL DEPTH TO WATER (ft TOC): ________ TIME FINAL DEPTH TAKEN: ________

SAMPLE ID: ________ SAMPLE ID FOR QC: ________

PARAMETERS REQUESTED FOR ANALYSIS: ________

WATER QUALITY METER MODEL No: ________

DO CHECK IN AIR: Before: ________ After: ________

HECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUNDWATER SAMPLING REPORT

DATE: 11/06/06 SITE: DCFA PID READING at WELL HEAD (ppm): ________

PROJECT NUMBER: 40904 WEATHER: ________

WELL NUMBER

DCF 92-05

DEPTH TO WATER (ft): 34.34

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): ________

PURGING

CASING VOLUME CALCULATION: _____ ft of water in casing X _____ gallons/foot = _____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1432:30		300	6.34	14.88	1.787		-17.6	6.30	
1435		300	6.63	14.32	1.816		-189.6	2.67	
1437:30		300	6.62	14.18	1.818		-196.4	3.54	
1440		300	6.68	14.14	1.820		-201.6	3.45	
1442:30		300	6.72	14.10	1.817		-194.7	4.50	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 8 TOTAL IRON (mg/L) ~~IDW TOTAL~~: 4

FINAL DEPTH TO WATER (ft TOC): ________ TIME FINAL DEPTH TAKEN: ________

SAMPLE ID: ________ SAMPLE ID FOR QC: ________

PARAMETERS REQUESTED FOR ANALYSIS: ________

WATER QUALITY METER MODEL No: ________

DO CHECK IN AIR: Before: ________ After: ________

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUNDWATER SAMPLING REPORT

DATE: 11/06/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

ROJECT NUMBER: 40904 WEATHER: ______

WELL NUMBER DEPTH TO WATER (ft): 41.16

DCF 06-40

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1452:30		200	6.51	17.01	1.960		-164.9	3.83	
1455		200	6.54	16.22	1.989		-189.3	1.86	
1457:30		200	6.66	15.98	2.000		-190.9	1.60	
1500		200	6.72	15.93	2.001		-193.7	1.37	
1502:30		200	6.74	15.94	1.999		-197.7	1.24	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.0 TOTAL IRON (mg/L) ~~IDW TOTAL~~: 0.2

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: ______

DO CHECK IN AIR: Before: ______ After: ______

HECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

FIELD GROUNDWATER SAMPLING REPORT

DATE: 11/06/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

PROJECT NUMBER: ______ WEATHER: ______

WELL NUMBER: DCF 02-41 DEPTH TO WATER (ft): 19.96

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1535		400	6.48	14.42	1.619		-169.9	4.22	
1537:30		400	6.79	14.31	1.618		-195.7	0.80	
1540		400	6.92	14.33	1.608		-208.3	0.44	
1542:30		400	6.92	14.34	1.617		-211.5	0.34	
1545		400	6.92	14.34	1.621		-212.4	0.30	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 4.5 IDW TOTAL: 4.5

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: ______

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

December 2006

FIELD GROUND-WATER SAMPLING REPORT

DATE: 12/04/06 SITE: NCFA PID READING at WELL HEAD (ppm): ______

PROJECT NUMBER: WEATHER: 40's, clear, Sunny

WELL NUMBER DEPTH TO WATER (ft): ______

Piezometer

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: _____ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
Permanganate present in well									

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): — IDW TOTAL: —

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: —

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE.: —

DO CHECK IN AIR: Before: — After:

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/5/06

FIELD GROUND-WATER SAMPLING REPORT

DATE: 12/4/06 SITE: DLFA PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: 40904 WEATHER: 40's, clear, Sunny

WELL NUMBER: DCF 02-42

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
Permangenate in well									

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): — IDW TOTAL: —

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: —

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE.: —

DO CHECK IN AIR: Before: — After: —

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/05/06

FIELD GROUND-WATER SAMPLING REPORT

DATE: 12/04/06 SITE: DCFA PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: 40904 WEATHER: 40's, Clear, Sunny

WELL NUMBER

06-25

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): ______

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
Permanganate present in well									

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): — IDW TOTAL: —

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: —

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE.: —

DO CHECK IN AIR: Before: — After: —

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	12/04/06
REVIEWED:	WB McClendon	WB McClendon	12/05/06

FIELD GROUNDWATER SAMPLING REPORT

DATE: 12/4/06 SITE: DCFA PID READING at WELL HEAD (ppm): ——

PROJECT NUMBER: 40964 WEATHER: 40's Clear, Sunny

WELL NUMBER: DCF 92-05

DEPTH TO WATER (ft): TOP

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1147	I	800	7.13	13.70	1.769	—	-60.6	1.23	
1150		300	7.00	13.65	1.768	—	-70.4	0.94	
1153		300	6.82	13.79	1.765	—	-67.0	0.75	
1156		300	6.80	13.82	1.766	—	-69.9	0.71	
1159		300	6.96	13.90	1.767	—	-86.2	0.58	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
					Clear				

FERROUS IRON (mg/L): 10+ mg/l ~~IDW TOTAL~~ Total Iron (mg/L): 0 mg/L

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: YSI 556 + Fe kit

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/5/06

FIELD GROUNDWATER SAMPLING REPORT

DATE: 12/4/06 SITE: DCFA PID READING at WELL HEAD (ppm): ______

PROJECT NUMBER: 40904 WEATHER: Clear, Sunny, 40's

WELL NUMBER: DCF 93-13

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1227	I	600	7.08	14.20	1.718	—	-12.0	7.18	38.47
~~1230~~		200	6.75	13.62	1.764	—	-16.8	6.89	
~~1235~~									
~~1234~~									
1246		200	6.93	12.31	2.409	—	-41.1	18.80	
1249		200	6.98	12.32	1.794	—	-47.4	2.38	
1252		200	7.01	13.82	1.711		-40.2	1.54	

BK 1240

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.4 ~~IRW TOTAL~~ Total Iron (mg/L): 0.4

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: YSI 556 + Fe kit

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Haslund	Chris Hoglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/5/06

FIELD GROUNDWATER SAMPLING REPORT

DATE: 12/4/06 SITE: DCFA PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: 40904 WEATHER: Sunny, Clear, 40's

WELL NUMBER: DCF 02-41 DEPTH TO WATER (ft): 19.87'

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1319	I		7.18	12.42	1.524		-39.8	7.55	20.93
1322		300	7.19	13.70	1.538		-90.0	4.45	
1325		300	7.20	13.65	1.532		-93.9	3.74	
1328		300	7.18	13.65	1.528		-96.3	2.84	
1331		300	7.18	13.50	1.540		-97.3	2.79	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 4.0 Total Fe (mg/L) ~~FE3 TOTAL~~: ______

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: YSI 556 + Fe Kit

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/5/06

FIELD GROUNDWATER SAMPLING REPORT

DATE: 12/4/06 SITE: DCFA PID READING at WELL HEAD (ppm): ——

PROJECT NUMBER: 40904 WEATHER: Clear, Sunny, 40's

WELL NUMBER: DCF 06-40

DEPTH TO WATER (ft): ______

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1207	I	200	6.81	13.81	1.885		-8.0	7.33	
1210		200	6.79	13.94	1.895		-5.7	2.82	
1213		200	6.88	14.14	1.906		-7.2	2.09	
1216		200	6.95	14.21	1.905		-22.4	2.01	
1219		200	6.99	14.25	1.903		-19.9	1.55	

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): 0.6 Total Iron (mg/L) ~~IDW TOTAL~~: 0.2

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

WATER QUALITY METER MODEL No: YSI 556 + Fe Kit

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Chris Haglund	Chris Haglund	12/4/06
REVIEWED:	WB McClendon	WB McClendon	12/5/06

April 2007
EA Consultants
LTM

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	41.82
Well ID	DCF92-01	Total Depth of Well (ft BTOC)	
Date	23APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.01	Screen above or below water column	
Zero DO	Pre 77.3 @ 1110 Post 94.9 @ 1212	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, slight breeze out of east, temp. 60's to 70's. Well condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	6-40ml VOA's	Sulfide	2-500ml ple
Methane/Ehtane/Ethene	6-40ml VOA's	TOC	2-125 ml Amber
Natural Attenuation + Alk	2-500ml ple	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1110	400	16.62	6.83	1.777	7.67	218.9	3.09	41.82
1115	400	16.49	6.28	1.803	41.8	229.7	0.72	42.02
1120	400	16.40	6.19	1.764	3.39	256.1	0.24	42.02
1125	400	16.37	6.11	1.821	2.89	281.6	—	42.02
1130	400	16.34	6.07	1.838	2.67	304.7	0.08	42.02
1135	400	16.35	5.99	1.844	2.56	325.9	—	42.02
1140	400	16.37	5.96	1.847	2.50	343.6	0.14	42.02
1145	400	16.39	5.89	1.849	2.47	360.0	—	42.02
1150	400	16.36	5.78	1.849	2.44	381.0	0.00	42.02
1155	400	16.37	5.69	1.850	2.41	399.3	-	42.02
1200	400	16.34	5.70	1.851	2.39	406.2	-	42.02
1205	400	16.41	5.67	1.852	2.39	409.0	-	42.02

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 41.82

Total volume purged (L): 14 L + 8 L

Sample ID(s): DCF92-01/01, DCF92-01/01X MS/MSD

QA/QC, MS/MSD samples:

Sample Time: 1215

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 23APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	34.12
Well ID	DCF92-05	Total Depth of Well (ft BTOC)	
Date	22 April 07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	1.15	Screen above or below water column	Above ____ Below ____
Zero DO	Pre 91.06 @ 1036 Post 93.2 @ 1124		

Observations (weather conditions, well,deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Partly cloudy, Wind out of south, Temp. 70's.
Bolt holding well cover missing. Condition of well good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD. DC

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA's	Sulfide	1-500 ml pl ~~Napthalene~~
Methane/Ehtane/Ethene	3-40ml VOA's	TOC	1-125ml Amber
Natural Attenuation + Alk	1-500 ml pl	~~Alkalinity~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if ≤0.5)	±10mV	<30 or +/- 10%	—
1038	300	15.46	6.40	1.911	55.40	50.8	18	34.12
1043	300	14.18	6.00	2.133	2.17	-52.8	—	34.45
1048	300	14.09	6.09	2.205	1.34	-81.8	3.4	34.52
1053	300	14.15	6.03	2.218	1.14	-81.8	—	34.61
1058	300	14.16	5.97	2.220	1.09	-79.8	0.80	34.64
1103	300	14.14	5.87	2.232	0.99	-78.4	—	34.70
1108	~~300~~ 200	14.11	5.78	2.242	0.94	-76.8	0.50	34.70
1113	200	14.11	5.72	2.251	0.91	-74.0	—	34.70
1118	200	14.11	5.78	2.257	0.92	-74.0	—	34.70

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 34.70

Total volume purged (L): 10

Sample ID(s): DCF92-05/01

QA/QC, MS/MSD samples: NA

Sample Time: 1125

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature Kent Dufan Date 22APR07

(2)

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC) Top of pump	BTOP
Well ID	DCF93-08	Total Depth of Well (ft BTOC) 37.05	
Date	23APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III		Screen above or below water column	
Zero DO Pre ___ @ ___ Post ___ @ ___		Above ___	Below ___

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
No. Sample hoses to pump are cut about 1' below top fittings. Lifted pump from well and pump was dry. No sample. @ 1045

Parameters stabilized prior to sample collection? YES NO (intials by each sampler)

Samples Collected	Volume Collected	Samples Collected	Volume Collected		
TCL Volatiles	No Sample	Sulfide		Napthalene	
Methane/Ehtane/Ethene		TOC			
Natural Attenuation		Alkalinity			

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±*0.5°C*	±*0.1*	±*3%*	±*10% or 0.1 (0.1 if <0.5)*	±*10mV*	*<30 or +/- 10%*	----
								BTOP
		No Sample						

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC):

Total volume purged (L):

Sample ID(s):

QA/QC, MS/MSD samples:

Sample Time:

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature Kent Dixon @1045 Date 23APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	35.30
Well ID	DCF93-13	Total Depth of Well (ft BTOC)	
Date	22APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD·DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	1.21	Screen above or below water column	
Zero DO	Pre 91.9 @ 1139 Post 92.7 @ 1230	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Partly Cloudy, windy, wind out of south, Temp 70's.
Well Condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) ⟶ KD·DC

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA's	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA's	TOC	1-125ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1140	200	15.84	6.66	1.779	6.68	72.0	4.6	35.30
1145	200	15.31	5.98	2.342	2.58	-142.0	—	36.10
1150	200	15.16	5.97	2.461	1.19	-188.7	2.6	36.38
1155	200	15.11	6.05	2.460	0.86	-208.7	—	36.61
1200	200	15.32	6.06	2.432	0.81	-230.5	1.7	36.72
1205	200	15.41	6.02	2.404	0.76	-244.8	—	36.72
1210	200	15.45	5.96	2.378	0.72	-253.9	1.6	36.72
1215	200	15.45	5.95	2.353	0.73	-260.0	—	36.72
1220	200	15.29	5.96	2.326	0.70	-266.7	—	36.72
1225	200	15.43	5.97	2.313	0.68	-269.7	—	36.72

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 36.72

Total volume purged (L): 10

Sample ID(s): DCF93-13/01

QA/QC, MS/MSD samples: NA

Sample Time: 1235

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 22APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	42.81
Well ID	DCF93-19	Total Depth of Well (ft BTOC)	
Date	23APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	1.65	Screen above or below water column	
Zero DO Pre 97.6 @0920	Post 98.2 @ 1015	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, slight wind out of east, 60's.
Well condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	9-40ml VOAs	Sulfide	3-500ml pl
Methane/Ehtane/Ethene	9-40ml VOAs	TOC	3-125ml Amber
~~Natural Attenuation~~ Alk	3-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0927	150	16.14	6.93	1.589	4.87	25.6	90	42.81
0932	150	16.07	6.81	1.579	4.12	-55.0	210	43.03
0937	150	15.92	6.75	1.563	3.94	-73.8	100	43.03
0942	150	15.92	6.70	1.558	3.31	-79.0	55	43.03
0947	150	15.93	6.68	1.558	3.33	-80.8	33	43.03
0952	150	15.97	6.63	1.557	3.29	-81.4	20	43.03
0957	150	16.00	6.62	1.559	3.33	-81.5	14	43.03
1002	150	16.03	6.60	1.559	3.01	-81.5	9.8	43.03

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 43.01

Total volume purged (L): 6

Sample ID(s): DCF93-19/01, DCF93-19/11 duplicate, DCF93-19/01QA @0930

QA/QC, MS/MSD samples:

Sample Time: 1012

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

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Signature [signature] Date 23APR07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

elevation 1045.51

Well Data

Site	DCFA	Depth to Water (ft BTOC)	43.47 ~~1048.57~~
Well ID	DCF93-20	Total Depth of Well (ft BTOC)	60.95
Date	22APR07	Height of Purge Column	
Well PID	NA	Well Diameter	top of pump 53.10
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	3.14 FT.
Field Fe III	0.05	Screen above or below water column	Above ____ Below 3.14 FT
Zero DO	Pre 93.2 @1258 Post 92.7 @1417		

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
System Volume 2.2 liters
Partly cloudy, windy, wind out of south. Temp 70's.
Well condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD · DC

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA's	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA's	TOC	1-125ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1301	100	15.63	6.04	1.939	6.11	-65.0	13	43.47
1306	100	14.64	6.39	2.898	3.30	-32.5	5.0	46.76
1311	100	14.31	6.26	2.782	2.77	-25.0	—	47.63
1316	100	14.30	6.26	2.432	3.05	-12.4	—	48.00
1321	100	14.31	6.34	2.261	3.24	-2.5	1.7	48.50
1326	100	14.15	6.32	2.120	3.23	8.6	—	49.02
1331	100	14.12	6.24	2.057	3.17	17.1	0.70	49.45
1336	100	14.13	6.23	2.026	3.09	24.2	—	49.81
1341	100	14.02	6.23	2.004	2.97	9.8	0.80	50.27
1346	100	14.02	6.23	1.984	2.78	5.7	—	50.68
1351	100	14.22	6.12	1.977	2.60	8.7	—	50.90
1356	100	14.35	6.06	1.979	2.49	11.8	0.30	51.00
1401	100	14.29	6.07	1.977	2.30	13.4	—	51.20
1406	100	14.26	6.08	1.978	2.12	13.4	—	51.38

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 49.40

Total volume purged (L): 6

Sample ID(s): DCF93-20/01

QA/QC, MS/MSD samples: NA

Sample Time: 1415

Well did not stablize at purge 100ml/min. Removed 3 system volumes. Parameters stable and then sampled.

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

(6)

Signature Kent Dipon Date 22APR07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	
Well ID	DCF06-25	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	Bailer	Screen to top or Water column differential	
Field Fe III		Screen above or below water column	

Zero DO Pre____ @____ Post____ @____ Above____ Below____

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Bailed well to test for presence of permaganate, purplewater
Second bailer water purple, No Sample

Parameters stabilized prior to sample collection? YES NO (intials by each sampler)

Samples Collected	Volume Collected	**Samples Collected**		Volume Collected
TCL Volatiles		Sulfide		Napthalene
Methane/Ehtane/Ethene		TOC		
Natural Attenuation		Alkalinity		

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	~~*Stable Water Level*~~	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—

No Sample

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC):

Total volume purged (L):

Sample ID(s):

QA/QC, MS/MSD samples:

Sample Time:

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

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Signature Kent Dyer Date 20APR07 1445

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	NA
Well ID	DCF96-27	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	JIG	Screen to top or Water column differential	
Field Fe III	0.94	Screen above or below water column	
Zero DO	Pre 94.0 @1225 Post 95.7 @1317	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.): Turbidity Not < 30. per Last event, Turbidity Level consistent all other parameters stable

well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) KD

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA's	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA's	TOC	1-125ml Amber
Natural Attenuation +Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1230	NA	16.78	6.47	1.281	5.89	54.5	160	NA
1235	NA	15.22	5.66	1.286	2.30	-52.3	140	NA
1240	NA	15.88	5.74	1.286	2.13	-39.9	190	NA
1245	NA	15.76	5.72	1.287	2.14	-34.5	260	NA
1250	NA	15.67	5.65	1.289	1.86	-31.2	330	NA
1255	NA	15.67	5.73	1.292	1.94	-28.8	300	NA
1300	NA	15.66	5.75	1.296	1.86	-29.7	280	NA
1305	NA	15.77	5.76	1.301	1.92	-29.9	300	NA
1310	NA	15.78	5.64	1.307	1.88	-27.9	270	NA
							190	

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC):

Total volume purged (L): 16

Sample ID(s): DCF96-27/01

QA/QC, MS/MSD samples: NA

Sample Time: 1325

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature Kent Dixon Date 20APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	
Well ID	DCF00-34C	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	Jiggle	Screen to top or Water column differential	
Field Fe III	2.51	Screen above or below water column	
Zero DO	Pre 96.5 @0840 Post 95.9 @0920	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.): per previous sampling, purged 6-gals and Turbidity did noT go down. Final turb → 550, parameters stable.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD-MW

Samples Collected	Volume Collected	Samples Collected		Volume Collected
TCL Volatiles	3-40 ml VOA's	Sulfide	1-500 ml pl	
Methane/Ehtane/Ethene	3-40 ml VOA's	TOC	1-125 ml Amber	
Natural Attenuation +AK	1-500 ml pl	~~Alkalinity~~		~~Napthalene~~

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0845	NA	13.30	7.21	1.148	4.09	-147.2	350	NA
0850	NA	14.55	6.76	1.772	0.64	-136.4	>1000	NA
0855	NA	14.66	6.78	1.792	0.76	-136.7	>1000	NA
0900	NA	14.45	6.81	1.801	0.86	-140.5	850	NA
0905	NA	14.58	6.83	1.810	0.80	-138.2	550	NA

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): NA

Total volume purged (L): 17 + 6 → 23 Liters

Sample ID(s): DCF00-34C

QA/QC, MS/MSD samples: NA

Sample Time: 0915

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 20APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	NA
Well ID	DCA99-36	Total Depth of Well (ft BTOC)	
Date	18APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD, MW	Well Volume	
Purge/Sample Method	JiggleTube	Screen to top or Water column differential	
Field Fe III	0.86	Screen above or below water column	Above ____ Below ____
Zero DO	Pre 96.2 @1437 Post 95.5 @ 1517		

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Partly cloudy, 70°s, well good
no wind

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl ~~Napthalene~~
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Water Quality Parameters: Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1440	NA	15.39	6.81	1.045	4.62	-73.4	180	NA
1445	NA	14.25	6.11	1.096	3.86	-93.2	280	NA
1450	NA	14.25	6.12	1.086	1.30	-60.2	110	NA
1455	NA	14.19	6.19	1.082	0.85	-34.1	55	NA
1500	NA	14.24	6.29	1.082	0.83	-32.6	50	NA
1505	NA	14.28	6.26	1.081	0.85	-41.2	28	NA

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): NA

Total volume purged (L): 22

Sample ID(s): DCA99-36/01

QA/QC, MS/MSD samples: NA

Sample Time: 1510

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 18Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	24.75
Well ID	DCF99-37C	Total Depth of Well (ft BTOC)	
Date	18APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	OBP	Screen to top or Water column differential	
Field Fe III	2.08 @ 20% 10.40 mg/L	Screen above or below water column	Above ___ Below ___
Zero DO	Pre 97.9 @ 0904 Post 97.3 @ 1004		

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Foggy, No wind, 50°s, clear, well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	9 8-40ml VOA	Sulfide	3 X-500ml pl
Methane/Ehtane/Ethene	9 8-40ml VOA	TOC	3 X-250ml amber
Natural Attenuation + Alk	3 X-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±*0.5°C*	±*0.1*	±*3%*	±*10% or 0.1 (0.1 if <0.5)*	±*10mV*	*<30 or +/- 10%*	—
0908	500	13.31	6.94	1.305	9.04	34.5	0.85	24.75
0913	500	14.33	6.63	1.638	2.11	-138.2	—	24.75
0918	500	14.51	6.59	1.611	4.25	-135.2	1.1	24.75
0923	500	14.56	6.57	1.608	1.37	-134.0	—	24.75
0928	500	14.59	6.58	1.607	1.36	-136.5	2.2	24.75
0933	500	14.62	6.59	1.606	1.29	-137.1	—	24.75
0938	500	14.68	6.58	1.617	1.21	-137.0	0.95	24.75
0943	500	14.68	6.58	1.622	1.19	-138.1	0.45	24.75

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 24.75

Total volume purged (L): 17

Sample ID(s): DCF99-37C/01

QA/QC, MS/MSD samples: DCF99-37C/11 - duplicate @ 0810, DCF99-37C/01QA - split

Sample Time: 0945

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well) =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 18Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	23.84
Well ID	DCF99-38C	Total Depth of Well (ft BTOC)	
Date	18APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.65 @ 20% 3.25 mg/L	Screen above or below water column	
Zero DO	Pre 97.3 @ 1015 Post 96.5 @ 1052	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Clear, 50°s, No wind, well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD & MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1018	500	14.22	6.74	1.620	7.46	-25.6	8.9	23.84
1023	500	14.70	6.60	1.442	1.56	-114.9	—	23.84
1028	500	14.76	6.61	1.430	0.91	-136.6	2.2	23.84
1033	500	14.84	6.65	1.430	0.72	-138.5	—	23.84
1038	500	14.83	6.69	1.430	0.67	-138.3	1.8	23.84
1043	500	14.80	6.67	1.430	0.63	-137.3	1.5	23.84

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 23.84

Total volume purged (L): 12

Sample ID(s): DCF99-38C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1050

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 18Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	40.36
Well ID	DCF06-40	Total Depth of Well (ft BTOC)	
Date	22APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.00	Screen above or below water column	
Zero DO	Pre 95.40 @ 0965 Post 97.3 @ 1018	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny. Wind out of south. Temp. 70's.
Well in good shape.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD-DC

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40 ml VOAS	Sulfide	1-500 ml pl
Methane/Ehtane/Ethene	3-40 ml VOAS	TOC	1-125 ml Amber
Natural Attenuation + Alk	1-500 ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0926	100 -	17.32	6.44	1.952	5.94	266.1	2.8	40.36
0931	100	16.43	6.11	1.905	1.87	318.1	—	40.63
0936	100	16.56	6.18	1.908	1.37	348.3	0.00	40.63
0941	100	16.59	6.22	1.919	1.27	366.6	—	40.63
0946	100	16.65	6.22	1.929	1.16	376.5	0.00	40.61
0951	100	16.69	6.20	1.940	1.09	386.4	—	40.61
0956	100	16.69	6.22	1.946	1.06	392.6	0.00	40.61
1001	100	16.71	6.24	1.951	1.05	394.0	—	40.63
1006	100	16.77	6.18	1.954	1.02	403.2	—	40.63

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 40.63

Total volume purged (L): 5

Sample ID(s): DCF06-40/01

QA/QC, MS/MSD samples: NA

Sample Time: 1015

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

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Signature [signature] Date 22APR07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA ~~23APR07~~	Depth to Water (ft BTOC)	18.80
Well ID	DCF02-41	Total Depth of Well (ft BTOC)	
Date	23APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.00	Screen above or below water column	
Zero DO	Pre 97.8% @0807 Post 93.6 @0900	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny. Slight breeze out of south. Cool, 50's.
Well condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	9-40ml VOA's	Sulfide	3-500ml pl
Methane/Ehtane/Ethene	9-40ml VOA's	TOC	3-12 5ml Amber
Natural Attenuation + Alk	3-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0810	200	12.51	6.98	1.552	9.01	155.2	9.4	18.80
0815	200	13.66	6.54	1.648	2.65	18.3	—	19.29
0820	200	13.71	6.67	1.691	1.10	-25.5	120	19.31
0825	200	13.70	6.74	1.710	0.81	-30.2	50	19.31
0830	200	13.74	6.77	1.717	0.71	-39.7	27	19.31
0835	200	13.77	6.79	1.719	0.66	-44.1	14	19.31
0840	200	13.81	6.80	1.720	0.62	-47.3	10	19.31
0845	200	13.82	6.81	1.719	0.59	-49.3	5.8	19.31

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 19.41

Total volume purged (L): 12

Sample ID(s): DCF02-41/01

QA/QC, MS/MSD samples: DCF02-41/11 → duplicate @0730, DCF02-41/01QA - Lab split

Sample Time: 0855

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

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Signature [signature] Date 23APR07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	
Well ID	DCF02-42	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	Bailer	Screen to top or Water column differential	
Field Fe III	NA	Screen above or below water column	

Zero DO Pre____ @____ Post____ @____ Above____ Below____

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Bailed well to test for presence of permaganate, purple water. second bailer water purple. No Sample.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) →

Samples Collected	Volume Collected	Samples Collected	Volume Collected		
TCL Volatiles		Sulfide		Napthalene	
Methane/Ehtane/Ethene		TOC			
Natural Attenuation		Alkalinity			

Purge Data

Time	Pump Flow Rate (ml/min)	Water Quality Parameters: Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±*0.5°C*	±*0.1*	±*3%*	±*10% or 0.1 (0.1 if <0.5)*	±*10mV*	*<30 or +/- 10%*	—

No sample

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC):

Total volume purged (L):

Sample ID(s):

QA/QC, MS/MSD samples:

Sample Time:

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 20APR07 @ 1505

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	17.87
Well ID	DCF-02-43	Total Depth of Well (ft BTOC)	
Date	22APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-DC	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.02	Screen above or below water column	
Zero DO	Pre 96.6 @0809 Post 95.40 @0915	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Over cast, windy out of south, 60°
Well condition good.

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD · DC

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml w/Hcl	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml w/Hcl	TOC	1-125ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	NA
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0812	350	14.31	7.11	1.181	8.19	229.7	7.0	17.87
0817	350	14.44	6.65	1.603	4.56	241.5	—	17.87
0822	350	14.46	6.62	1.086	4.28	251.3	12	17.87
0827	350	14.46	6.64	1.083	4.20	260.4	—	17.87
0832	350	14.49	6.62	1.081	4.16	267.6	7.72	17.87
0837	350	14.44	6.62	1.080	4.14	275.4	—	17.87
0842	350	14.42	6.63	1.079	4.14	282.2	4.8	17.87
0847	350	14.46	6.64	1.079	4.14	285.2	-	17.87

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 17.87

Total volume purged (L): 15

Sample ID(s): DCF02-43/01

QA/QC, MS/MSD samples: NA

Sample Time: 0850

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

(16)

Signature [signature]

Date 22APR07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	~~21.71~~ 19.64
Well ID	DCF02-44A	Total Depth of Well (ft BTOC)	
Date	19APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.03	Screen above or below water column	Above ___ Below ___
Zero DO	Pre ~~97.3~~ 97.5 @ ~~0838~~	Post ~~97.5~~ 96.7 @ ~~0924~~ 1122 1298	

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Clear, 60°s, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min) 35	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1125	200	16.22	6.41	2.005	3.56	-0.5	26.6	19.64
1130	200	15.04	6.15	1.944	1.16	-7.3	—	19.64
1135	200	15.21	6.18	1.925	0.99	6.18	2.83	19.64
1140	200	15.22	6.19	1.929	0.93	6.19	—	19.64
1145	200	15.25	6.05	1.929	0.86	59.5	1.25	19.64
1150	200	15.28	6.13	1.928	0.91	58.6	—	19.64
1155	200	15.32	6.10	1.934	0.92	65.3	0.33	19.64
1200	200	15.23	6.05	1.933	0.88	68.2	—	19.64

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 19.64

Total volume purged (L): 6

Sample ID(s): DCF02-44A/01

QA/QC, MS/MSD samples: NA

Sample Time: 1205

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature__________ Date______

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	19.63
Well ID	DCF02-44C	Total Depth of Well (ft BTOC)	
Date	19APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.0	Screen above or below water column	Above ____ Below ____

Zero DO Pre 82.3 @ 1029 Post 94.4 @ 1113

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, 60's, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	25 Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	*±0.5°C*	*±0.1*	*±3%*	*±10% or 0.1 (0.1 if <0.5)*	*±10mV*	*<30 or +/- 10%*	—
1034	300	15.10	6.62	1.733	5.89	221.8	6.14	19.63
1039	300	14.88	6.36	1.833	1.55	240.2	—	19.63
1044	300	14.87	6.33	1.842	1.14	246.0	2.46	19.63
1049	300	14.87	6.32	1.842	1.00	253.4	—	19.63
1054	300	14.86	6.35	1.840	0.88	262.9	1.51	19.63
1059	300	14.88	6.33	1.839	0.82	267.9	—	19.63
1104	300	14.85	6.28	1.840	0.76	271.2	1.11	19.63
1109	300	14.78	6.29	1.838	0.73	264.4	1.03	19.63

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 19.63

Total volume purged (L): 10

Sample ID(s): DCF02-44C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1115

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 19 Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	26.06
Well ID	DCF02-46A	Total Depth of Well (ft BTOC)	
Date	19APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.05	Screen above or below water column	Above ____ Below ____
Zero DO	Pre 96.4 @ 1327	Post 95.4 @ 1416	

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, 70°s, S wind
well good

Parameters stabilized prior to sample collection? (YES) NO (intials by each sampler) → KD & MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min) 25	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	*±0.5°C*	*±0.1*	*±3%*	*±10% or 0.1 (0.1 if <0.5)*	*±10mV*	*<30 or +/- 10%*	—
1329	500	15.59	5.73	1.167	5.83	397.3	2.28	26.06
1334	500	15.57	5.35	1.153	1.66	444.6	—	26.06
1339	500	15.59	5.37	1.153	1.27	454.1	0.27	26.06
1344	500	15.54	5.39	1.153	1.06	457.9	—	26.06
1349	500	15.51	5.48	1.153	0.98	456.5	0.05	26.06
1354	500	15.48	5.57	1.153	0.94	452.7	—	26.06
1359	500	15.46	5.63	1.152	0.91	448.9	0.05	26.06
~~13~~1404	500	15.50	5.64	1.153	0.89	446.2	0.26	26.06

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 26.06

Total volume purged (L): 16

Sample ID(s): DCF02-46A/01

QA/QC, MS/MSD samples: NA

Sample Time: 1410

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ______

Signature [signature] Date 19Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	25.88
Well ID	DCF02-46C	Total Depth of Well (ft BTOC)	
Date	19Apr07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.0	Screen above or below water column	
Zero DO	Pre 96.7 @1225 Post 96.4 @1327	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, 70°s, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD + MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	6 ~~3~~-40ml VOA	Sulfide	2 X-500ml pl
Methane/Ehtane/Ethene	6 ~~3~~-40ml VOA	TOC	2 X-250ml Amber
Natural Attenuation + Alk	2X-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	25 Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1228	500	16.63	7.12	1.021	8.29	193.9	1.87	25.88
1233	500	15.50	5.98	1.095	3.80	277.2	–	25.88
1238	500	15.40	5.76	1.098	3.43	327.1	2.81	25.88
1243	500	15.37	5.70	1.099	3.34	354.6	–	25.88
1248	500	15.38	5.72	1.100	3.29	372.8	—	25.88
1253	500	15.40	5.75	1.101	3.25	382.8	1.38	25.88
1258	500	15.38	5.78	1.101	3.22	393.3	—	25.88
1303	500	15.41	5.77	1.101	3.21	397.3	0.84	25.88
1308	500	15.40	5.81	1.101	3.20	401.2	0.40	25.88

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 25.88

Total volume purged (L): 18

Sample ID(s): DCF02-46C/01

QA/QC MS/MSD samples: DCF02-46C/01X

Sample Time: 1315

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 19Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCEA	Depth to Water (ft BTOC)	22.06
Well ID	DCF02-47A	Total Depth of Well (ft BTOC)	
Date	19APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.03	Screen above or below water column	
Zero DO	Pre 97.5 @ 0924 Post 82.3 @ 1029	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
sunny, low 60°s, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD + MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	15 Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±*0.5°C*	±*0.1*	±*3%*	±*10% or 0.1 (0.1 if <0.5)*	±*10mV*	*<30 or +/- 10%*	—
0928	500	13.63	7.07	1.573	8.02	173.6	0.95	22.06
0933	500	14.46	6.80	1.263	2.37	188.0	—	22.06
0938	500	14.50	6.82	1.250	1.81	188.6	0.45	22.06
0943	500	14.52	6.85	1.250	1.50	190.8	—	22.06
0948	500	14.57	6.83	1.247	0.94	181.9	0.35	22.06
0953	500	14.61	6.80	1.247	0.89	190.6	—	22.06
0958	500	14.64	6.75	1.247	0.86	195.9	0.60	22.06

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 22.06

Total volume purged (L): 12

Sample ID(s): DCF02-47A/01

QA/QC, MS/MSD samples: NA

Sample Time: 1005

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____-depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 19Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	21.71
Well ID	DCF02-47C	Total Depth of Well (ft BTOC)	
Date	19APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD.MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.04	Screen above or below water column	
Zero DO	Pre 97.3 @ 0843 Post 97.5 @ 0924	Above ____	Below ____

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, 50°s, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD + MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	
Natural Attenuation	1-500ml pl	Alkalinity	
		Napthalene	

Purge Data

Time	Pump Flow Rate (ml/min) 40	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/-10%	—
0845	500	13.20	7.68	0.983	8.56	148.8	13	21.71
0850	500	14.48	6.75	1.112	3.33	180.0	—	21.71
0855	500	14.51	6.74	1.109	2.44	184.9	11	21.71
0900	500	14.54	6.73	1.109	2.10	189.4	—	21.71
0905	500	14.59	6.73	1.108	2.03	196.1	6.5	21.71
0910	500	14.57	6.72	1.108	1.95	198.1	5.7	21.71

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 21.71

Total volume purged (L): 10

Sample ID(s): DCF02-47C

QA/QC, MS/MSD samples: NA

Sample Time: 0915

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature]   Date 19Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	18.98
Well ID	DCF02-48A	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.49	Screen above or below water column	
Zero DO	Pre 94.3 @ 1030 Post 93.7 @ 1108	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, 70's, S wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min) 30	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1033	500	15.11	6.53	1.380	2.89	-84.2	3.2	18.98
1038	500	14.99	6.44	1.378	0.73	-110.9	—	18.98
1043	500	15.00	6.44	1.355	0.65	-109.8	0.90	18.98
1048	500	15.05	6.43	1.335	0.59	-108.2	—	18.98
1053	500	15.08	6.41	1.322	0.56	-105.4	0.45	18.98

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 18.98

Total volume purged (L): 10

Sample ID(s): DCF02-48A/01

QA/QC, MS/MSD samples: NA

Sample Time: 1100

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 20Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	18.98
Well ID	DCF02-48C	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.02	Screen above or below water column	Above ____ Below ____
Zero DO	Pre 93.7 @ 1110	Post 93.9 @ 1208	

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, S wind, 70°s
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) ⟶ KD, MW

Samples Collected	Volume Collected	**Samples Collected**	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250 ml Amber
Natural Attenuation + Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	15 Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	*±0.5°C*	*±0.1*	*±3%*	*±10% or 0.1 (0.1 if <0.5)*	*±10mV*	*<30 or +/- 10%*	—
1117	450	15.62	7.03	1.159	7.21	-13.6	3.0	18.98
1122	400	15.19	6.50	1.194	2.12	45.6	—	18.98
1127	400	15.19	6.44	1.191	0.93	64.4	3.5	18.98
1132	400	15.29	6.38	1.191	0.71	85.4	—	18.98
1137	400	15.33	6.28	1.192	0.63	104.8	1.8	18.98
1142	400	15.31	6.20	1.192	0.60	119.8	—	18.98
1147	400	15.44	6.14	1.192	0.57	132.8	—	18.98
1152	400	15.28	6.06	1.192	0.55	133.4	1.4	18.98
1157	400	15.30	5.98	1.192	0.54	141.6	—	18.98

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 18.98

Total volume purged (L): 14

Sample ID(s): DCF02-48C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1205

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 20Apr07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	OCFA	Depth to Water (ft BTOC)	11.65
Well ID	DCF02-49C	Total Depth of Well (ft BTOC)	
Date	20APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	1.52	Screen above or below water column	Above ____ Below ____
Zero DO	Pre 95.9 @0930 Post 95.5 @1017		

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
clear skies ≈70°s, South wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD-MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40 ml VOA's	Sulfide	1-500 ml pl
Methane/Ehtane/Ethene	3-40 ml VOA's	TOC	1-125 ml Amber
Natural Attenuation + Alk	1-500 ml pl	~~Alkalinity~~	NA
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min) 20	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
		Water Quality Parameters						
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
0940	400	14.70	6.92	1.604	5.63	8.8	50	11.65
0945	400	14.37	6.52	1.554	1.20	-67.7	23	11.65
0950	400	14.35	6.50	1.551	0.79	-83.7	—	11.65
0955	400	14.37	6.49	1.550	0.68	-87.7	17	11.65
1000	400	14.40	6.47	1.551	0.63	-88.5	—	11.65
1065	400	14.42	6.44	1.552	0.61	-89.2	9.5	11.65

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 11.65

Total volume purged (L): 10

Sample ID(s): DCF02-49C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1015

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature Kent D[illegible] Date 20APR07

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Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	20.91
Well ID	DCF03-50C	Total Depth of Well (ft BTOC)	
Date	18APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe II	0.02 ~~@~~ 1303	Screen above or below water column	
Zero DO	Pre 96.5 @ ~~1503~~ Post 96.9 @ 1432	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Clear, Mostly sunny, 70°s, no wind
well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KP, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl ~~Napthalene~~
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation 4 Alk	1-500ml pl	~~Alkalinity~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1306	200	17.25	7.27	1.356	10.78	71.9	3.1	20.91
1311	200	15.20	5.66	1.486	2.88	153.9	—	20.91
1316	200	15.03	5.60	1.543	1.39	206.8	1.8	20.91
1321	200	14.84	5.66	1.554	1.03	231.5	—	20.91
1326	200	14.56	5.81	1.553	0.89	241.0	0.90	20.91
1331	200	14.43	5.95	1.551	0.78	236.5	—	20.91
1336	200	14.52	6.18	1.551	0.71	231.0	0.45	20.91
1341	200	14.57	6.16	1.554	0.67	240.6	—	20.91
1346	200	14.19	6.02	1.552	0.62	253.3	0.5	20.91
1351	200	14.03	6.19	1.552	0.58	243.4	—	20.91
1356	200	14.00	6.27	1.552	0.55	236.2	0.7	20.91
~~13~~1401	200	14.12	6.41	1.552	0.54	226.2	—	20.91
1406	200	14.04	6.35	1.553	0.51	232.0	0.95	20.91
1411	200	13.96	6.32	1.553	0.49	235.0	0.75	20.91

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 20.91

Total volume purged (L): 20

Sample ID(s): DCF03-50C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1415

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vloume = 0.7344 x (TD_____ - depth to saturation_____) + [(TD_____-WL_____)x 0.163] x 3 = _____

Signature [signature] Date 18Apr07

Fort Riley, KS Periodic Groundwater Sampling
Well Purge Form

Well Data

Site	DCFA	Depth to Water (ft BTOC)	20.08
Well ID	354-99-11C	Total Depth of Well (ft BTOC)	
Date	18APR07	Height of Purge Column	
Well PID	NA	Well Diameter	
Sampler(s)	KD-MW	Well Volume	
Purge/Sample Method	DBP	Screen to top or Water column differential	
Field Fe III	0.27 @ 20% =1.35 mg/L	Screen above or below water column	
Zero DO	Pre 96.5 @ 1113 Post 96.3 @ 1152	Above	Below

Observations (weather conditions, well deterioration/damage, evidence of tampering, odor, exemption (if any) and reason, etc.):
Sunny, clear, 60°s well good

Parameters stabilized prior to sample collection? YES NO (intials by each sampler) → KD, MW

Samples Collected	Volume Collected	Samples Collected	Volume Collected
TCL Volatiles	3-40ml VOA	Sulfide	1-500ml pl
Methane/Ehtane/Ethene	3-40ml VOA	TOC	1-250ml Amber
Natural Attenuation 4 Alk	1-500ml pl	~~Alkalinity~~	
		~~Napthalene~~	

Purge Data

Time	Pump Flow Rate (ml/min)	Temperature (°C)	pH	Specific Conductivity (mmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to GW (ft BTOC)
Initial Stablization Criteria	*Stable Water Level*	±0.5°C	±0.1	±3%	±10% or 0.1 (0.1 if <0.5)	±10mV	<30 or +/- 10%	—
1114	450	16.38	6.64	1.876	9.28	-6.0	1.3	20.08
1119	450	15.98	5.76	2.006	1.53	-88.2	—	20.08
1124	450	15.95	5.73	2.005	1.02	-93.6	0.65	20.08
1129	450	16.02	5.66	1.999	0.87	-90.9	—	20.08
1134	450	15.99	5.58	1.997	0.80	-91.8	0.75	20.08
1139	450	16.02	5.56	1.994	0.75	-92.8	~~0~~	20.08
1144	450	16.06	5.48	1.993	0.71	-88.5	7.1	20.08

Final (post sample) depth to groundwater prior to pump shutoff (ft BTOC): 20.08

Total volume purged (L): 14

Sample ID(s): 354-99-11C/01

QA/QC, MS/MSD samples: NA

Sample Time: 1150

Well Voume = (bore dia)^2 - (well dia)^2 x (0.0408) x (TD-depth to saturated filter pack) x 0.30 + (total depth - water level x 0.163) x 3

8 inch bore with two inch well =

Vlome = 0.7344 x (TD____ - depth to saturation____) + [(TD____-WL____)x 0.163] x 3 = ____

Signature [signature] Date 18 Apr 07

(27)

June 2007

FIELD GROUND-WATER SAMPLING REPORT

DATE: 6/19/07 SITE: DCFA PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: ____ WEATHER: Mostly Sunny, 80's

WELL NUMBER: DCF 92-01

DEPTH TO WATER (ft): 41.26'

TOTAL DEPTH (ft): ____ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1630	I	200	6.65	20.70	1.675	—	209.7	8.70	14.33
1635	0.26	200	6.31	18.63	1.678	—	215.3	5.39	14.34
1640	0.52	200	6.32	18.15	1.704	—	194.0	4.17	14.34
1645	0.78	200	6.39	17.87	1.673	—	169.3	3.92	14.34
1650	1.04	200	6.46	17.78	1.697	—	154.1	3.67	14.34
1655	1.44	300	6.47	17.20	1.698	—	144.6	3.45	14.36
1700	1.84	300	6.46	17.13	1.700	—	135.5	3.30	14.36
1705	2.24	300	6.20	17.04	1.587	—	127.4	3.64	14.36
1710	2.64	300	6.07	17.04	1.625	—	124.3	3.36	14.36
1715	3.04	300	6.07	17.02	1.670	—	123.3	3.11	14.36
1720	3.44	300	6.07	17.02	1.694	—	117.9	2.95	14.36
1725	3.84	300	6.07	17.02	1.707	—	115.1	2.85	14.36
						—			

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above Other ____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	3.84	6.07	17.02	1.707	—	115.1	2.85	14.36	Clear

FERROUS IRON (mg/L): — ALKALINITY (mg/L): — IDW TOTAL: 3.84

FINAL DEPTH TO WATER (ft TOC): 14.36 TIME FINAL DEPTH TAKEN: 1726

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: NA

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE.: YSI 556 MPS

DO CHECK IN AIR: Before: 100.1 After: 99.8

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: ____

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	6/19/07
REVIEWED:	W.B. McClenda	WB McClenda	06/20/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 6/19/07 SITE: DCFA Ft. Riley, KS PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: ____ WEATHER: Overcast, 70's

WELL NUMBER: DCF 93-13

DEPTH TO WATER (ft): 33.95

TOTAL DEPTH (ft): ____ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1857	I	300	6.58	15.26	2.116	—	-51.0	1.55	34.76
1902	0.40	300	6.64	15.32	2.142	—	-55.4	1.64	34.82
1907	0.80	300	6.64	15.24	2.145	—	-58.3	1.02	34.85
1912	1.20	300	6.63	15.24	2.141	—	-61.5	0.58	34.85
1917	1.60	300	6.61	14.97	2.120	—	-64.0	0.39	34.84
1922	2.00	300	6.65	15.33	2.130	—	-68.9	0.43	34.85
1927	2.40	300	6.63	15.25	2.106	—	-70.4	0.28	34.85
1932	2.80	300	6.62	15.23	2.082	—	-72.9	0.29	34.85
1937	3.20	300	6.58	15.60	2.091	—	-73.9	0.26	34.85

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	3.20	6.58	15.60	2.091	—	-73.9	0.26	34.85	Clear

FERROUS IRON (mg/L): — ALKALINITY (mg/L): — IDW TOTAL: ____

FINAL DEPTH TO WATER (ft TOC): 34.85 TIME FINAL DEPTH TAKEN: 1938

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: NA

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE.: YSI 556 MPS

DO CHECK IN AIR: Before: 100.8 After: 100.5

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: ____

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	6/19/07
REVIEWED:	WB McClendon	WB McClendon	6/20/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 6/19/07 SITE: DCFA PID READING at WELL HEAD (ppm): —

PROJECT NUMBER: ____ WEATHER: Mostly Sunny, 80's

WELL NUMBER: DCF 06-40

DEPTH TO WATER (ft): 38.36'

TOTAL DEPTH (ft): ____ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1740	I	100	6.67	20.37	1.782	—	125.8	6.69	38.39
1745	0.13	150	6.59	18.50	1.714	~	112.9	2.44	38.39
1750	0.33	150	6.58	17.90	1.687	—	101.2	1.05	38.39
1755	0.53	150	6.58	17.78	1.681	—	93.6	0.82	38.39
1800	0.73	150	6.58	17.68	1.680	—	88.1	0.65	38.39
1805	0.93	150	6.58	17.63	1.678	—	82.5	0.56	38.39
1810	1.13	150	6.58	17.59	1.679	—	78.2	0.53	38.39
1815	1.33	150	6.58	17.63	1.678	—	75.6	0.48	38.39

Continued on back (circle one) yes / no

SAMPLING

Equipment Used: Same as above Other ____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	1.33	6.58	17.63	1.678	—	75.6	0.48	38.39	Clear

FERROUS IRON (mg/L): — ALKALINITY (mg/L): — IDW TOTAL: 1.33

FINAL DEPTH TO WATER (ft TOC): 1818 TIME FINAL DEPTH TAKEN: 38.37'

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: N/A

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: YSI 556 MPS

DO CHECK IN AIR: Before: 99.7 After: 99.9

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: ____

	NAME	SIGNATURE	DATE
PREPARED:	Chris Hoglund	Chris Hoglund	6/19/07
REVIEWED:	WB McClendon	WB McClendon	6/20/07

July 2007

FIELD GROUND-WATER SAMPLING REPORT

TE: 7/18/07 SITE: DCFA PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: WEATHER: Sunny, 95°F

WELL NUMBER DEPTH TO WATER (ft): 18.43

DCF 02-41

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: _____ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1522	I	300	6.98	15.76	1.590	—	-86.0	7.82	19.12
1527	0.40	300	6.90	15.36	1.605	—	-108.4	3.60	19.01
1532	0.80	300	6.89	14.97	1.610	—	-123.8	1.84	19.10
1537	1.20	300	6.88	14.96	1.611	—	-126.1	1.28	19.13
1542	1.60	300	6.88	14.90	1.613	—	-127.0	0.83	19.10
1547	2.00	300	6.88	14.89	1.613	—	-129.2	0.61	19.18
1552	2.40	300	6.88	14.87	1.613	—	-129.9	0.49	19.16
57	2.80	300	6.88	14.82	1.614	—	-129.0	0.37	19.21
02	3.20	300	6.88	14.86	1.612	—	-130.0	0.31	19.18
1607	3.60	300	6.88	14.87	1.611	—	-126.5	0.28	19.24
1612	4.00	300	6.88	14.82	1.611	—	-128.9	0.29	19.22

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ftTOC)	Obs.
—	4.00	6.88	14.82	1.611	—	-128.9	0.29	19.22	Clear

FERROUS IRON (mg/L): — IDW TOTAL: 4.00

FINAL DEPTH TO WATER (ft TOC): 19.22 TIME FINAL DEPTH TAKEN: 1612

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: —

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE: YSI 556 MPS

CHECK IN AIR: Before: 101.0 After: 100.3

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: —

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 6/19 SITE: DLFA PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: WEATHER: Sunny, 95°F

WELL NUMBER DEPTH TO WATER (ft): 35.72

DCF 93-13

TOTAL DEPTH (ft): ________ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1418	I	300	6.54	15.97	2.740	—	-162.9	3.93	35.73
1423	0.40	300	6.57	15.46	2.715	—	-186.1	1.12	36.23
1428	0.80	300	6.58	15.41	2.658	—	-201.9	0.85	36.51
1433	1.20	300	6.60	15.59	2.606	—	-206.2	0.73	36.59
1438	1.60	300	6.60	16.75	2.551	—	-209.4	0.69	36.36
1443	2.00	300	6.61	17.06	2.534	—	-212.8	0.81	32.20
1448	2.40	300	6.65	15.64	2.471	—	-218.2	0.55	36.42
1453	2.80	300	6.63	18.88	2.463	—	-222.2	0.45	36.50
1458	3.20	300	6.64	15.80	2.438	—	-225.0	0.43	36.69
1503	3.60	300	6.65	16.00	2.419	—	-226.6	0.46	36.55

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	3.60	6.65	16.00	2.419	—	-226.6	0.46	36.55	Clear

FERROUS IRON (mg/L): — IDW TOTAL: 3.60

FINAL DEPTH TO WATER (ft TOC): 36.55 TIME FINAL DEPTH TAKEN: 1503

SAMPLE ID: NA SAMPLE ID FOR QC: NA

PARAMETERS REQUESTED FOR ANALYSIS: None

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE: YSI 556 MPS

DO CHECK IN AIR: Before: 99.7 After: 100.2

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

TE: 7/18/07 SITE: DCFA-Ft.Riley PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: 40904 WEATHER: Sunny, 90°F

WELL NUMBER: DCF 92-05

DEPTH TO WATER (ft): 34.13

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1136	I	300	6.69	15.41	2.182	—	-60.1	8.41	34.40
1141	0.39	300	6.57	14.42	2.247	—	-113.2	2.01	34.40
1146	0.78	300	6.63	14.36	2.253	—	-124.4	1.61	34.67
1151	1.17	300	6.66	14.37	2.246	—	-124.9	1.53	34.76
1156	1.56	300	6.66	14.33	2.222	—	-122.6	1.21	34.78
1201	1.95	300	6.66	14.29	2.209	—	-122.7	1.10	34.80
1206	2.24	300	6.66	14.30	2.188	—	-125.5	0.91	34.90
1211	2.63	300	6.66	14.00	2.175	—	-129.2	0.84	34.81
1216	3.02	300	6.66	14.69	2.164	—	-129.2	0.78	34.71
1221	3.41	300	6.67	14.36	2.153	—	-129.5	0.61	34.86
1226	3.80	300	6.67	14.35	2.133	—	-130.5	0.55	34.89
1231	4.19	300	6.69	14.37	2.126	—	-130.9	0.56	34.84

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	4.19	6.69	14.37	2.126	—	-130.9	0.56	34.84	Clear

FERROUS IRON (mg/L): — IDW TOTAL: 4.19

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: None

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE: YSI 556 MPS

CHECK IN AIR: Before: 99.8 After: 100.1

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: —

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/18/07 SITE: DCFA PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: 40904 WEATHER: Sunny, 95°F

WELL NUMBER: DCF 06-40 DEPTH TO WATER (ft): 39.78

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ____ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1258	I	150	6.53	19.70	1.895	—	44.4	3.13	39.87
1303	0.20	150	6.61	19.16	1.895	—	39.0	1.26	39.91
1308	0.40	150	6.63	18.91	1.896	—	32.9	0.68	39.93
1313	0.60	150	6.64	18.91	1.898	—	29.7	0.58	39.95
1318	0.80	150	6.65	18.81	1.899	—	26.5	0.43	39.99
1323	1.00	150	6.65	18.81	1.899	—	22.1	0.43	39.95
1328	1.20	150	6.72	18.85	1.898	—	-8.5	0.41	39.98
1333	1.40	150	6.70	18.79	1.899	—	-4.1	0.35	39.97
1338	1.60	150	6.67	18.82	1.900	—	-1.2	0.27	40.02
1343	1.80	150	6.63	18.75	1.903	—	4.8	0.29	40.01
1348	2.00	150	6.67	18.74	1.909	—	2.1	0.23	40.01
1353	2.20	150	6.65	18.71	1.903		~~1.0~~	0.24	39.97
1358	2.40	150	6.65	18.67	1.903	—	-0.8	0.24	39.99

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	2.40	6.65	18.67	19.03	—	-0.8	0.24	39.99	Clear

FERROUS IRON (mg/L): — IDW TOTAL: 2.40

FINAL DEPTH TO WATER (ft TOC): 39.99 TIME FINAL DEPTH TAKEN: 1359

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: None

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE: YSI 556 MPS

DO CHECK IN AIR: Before: 100.4 After: 100.2

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07
REVIEWED:			

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/18/07 SITE: DCFA PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: WEATHER: Sunny, 95°F

WELL NUMBER DEPTH TO WATER (ft): 20.15

DCF 06-25

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1715	6	Well water turned purple after ≈ 6 gals purged							

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): — IDW TOTAL: 6

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: —

DO METER MODEL No.: — ORP METER MODEL No.: — FLOW CELL TYPE: —

CHECK IN AIR: Before: — After: —

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: —

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07

REVIEWED:

FIELD GROUND-WATER SAMPLING REPORT

DATE: 7/18/07 SITE: DCFA PID READING at WELL HEAD (ppm): 0.0

PROJECT NUMBER: WEATHER: 95°F, Sunny

WELL NUMBER DEPTH TO WATER (ft): 29.87

DCF02-42

TOTAL DEPTH (ft): ______ WELL DIAMETER (inches): 2"

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water - (ft TOC)
1625	2.5	Well bailed until purple color was observed, approximately 2.5 Gals purged.							

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.

FERROUS IRON (mg/L): — IDW TOTAL: 2.5

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: — SAMPLE ID FOR QC: —

PARAMETERS REQUESTED FOR ANALYSIS: None

DO METER MODEL No.: / ORP METER MODEL No.: / FLOW CELL TYPE.: /

?? CHECK IN AIR: Before: N/A After: ________

CHECKED FLOW THROUGH CELL FOR LEAKS: ☒ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:	Kevin White	[signature]	7/18/07

REVIEWED:

August 2007

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): 0

PROJECT NUMBER: 40904 WEATHER: Clear hot

WELL NUMBER

DCF 92-05

DEPTH TO WATER (ft): —

TOTAL DEPTH (ft): — WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1105	I	200	6.45	15.05	1.366	—	38.8	~~55.75~~ 5.57	—
1107:30	.250	200	6.66	14.60	1.346	—	1.1	2.89	—
1110	0.50	200	6.79	14.35	1.323	—	-21.9	2.08	—
1112:30	0.75	200	6.80	14.40	1.319	—	-29.3	2.26	—
1115	1.0	200	6.81	14.45	1.321	—	-31.9	1.97	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1115	1.0	6.81	14.45	1.321	—	-31.9	1.97	—	—

FINAL DEPTH TO WATER (ft TOC): ______ TIME FINAL DEPTH TAKEN: ______

SAMPLE ID: none SAMPLE ID FOR QC: none

PARAMETERS REQUESTED FOR ANALYSIS: ______

FERROUS IRON (mg/L): 0.6 VOC pH: — IDW TOTAL: 1.0

Total Iron: 1.0

DO METER MODEL No.: YSI ORP METER MODEL No.: YSI

DO IN AIR: ______ DO IN ZERO OXYGEN SOLUTION.: --

CHECKED FLOW THROUGH CELL FOR LEAKS: ☑ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	W B McClendon	W B McClendon	8/21/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 08/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): 0

PROJECT NUMBER: 40904 WEATHER: clear, hot

WELL NUMBER

DCF 93-13

DEPTH TO WATER (ft): –

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ____ ft of water X ____ gallons/ = ____ total gallons/casing volume
in casing foot

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1042	~~0~~	300	6.63	15.44	1.352	–	-26.7	2.90	–
1044.5	0.25	300	6.91	15.10	1.241	–	-77.3	1.00	–
1047	.5	300	7.00	14.98	1.212	–	-97.8	0.63	–
1049.5	.75	300	7.03	14.91	1.206	–	-107.5	0.47	–
1052	1.0	300	7.04	14.90	1.206	–	-113.4	0.40	–

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1052	1.0	7.04	14.90	1.206	–	-113.4	0.40	–	–

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: none SAMPLE ID FOR QC: none

PARAMETERS REQUESTED FOR ANALYSIS: none

FERROUS IRON (mg/L): 7.0 VOC pH: – IDW TOTAL: 1.0

TOTAL IRON (mg/L): 8.0

DO METER MODEL No.: YSI ORP METER MODEL No.: YSI

DO IN AIR: – DO IN ZERO OXYGEN SOLUTION.: –

CHECKED FLOW THROUGH CELL FOR LEAKS: ☑ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	WB McClendon	WB McClendon	08/24/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): 0

PROJECT NUMBER: 40984 WEATHER: clear, hot

WELL NUMBER

DCF 02-41

DEPTH TO WATER (ft): —

TOTAL DEPTH (ft): — WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1152	—	200	6.52	16.89	1.356	—	92.4	0.15	—
1154:30	—	200	6.99	15.00	1.330	—	-44.7	1.21	—
1157	—	200	7.01	14.90	1.322	—	-66.3	1.10	—
1159:30	—	200	7.03	14.90	1.320	—	-68.4	1.09	—
1202	—	200	7.04	14.84	1.319	—	-70.8	1.08	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1202	—	7.04	14.84	1.319	—	-70.8	1.08	—	—

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: none SAMPLE ID FOR QC: none

PARAMETERS REQUESTED FOR ANALYSIS: none

FERROUS IRON (mg/L): 5.0 VOC pH: — IDW TOTAL: —

TOTAL IRON (mg/L): 7.0

DO METER MODEL No.: YSI ORP METER MODEL No.: YSI

DO IN AIR: — DO IN ZERO OXYGEN SOLUTION.: —

CHECKED FLOW THROUGH CELL FOR LEAKS: ☑ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	W B McClendon	W B McClendon	08/24/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/06 SITE: DCFA PID READING at WELL HEAD (ppm): 0

PROJECT NUMBER: 40904 WEATHER: clear, hot

WELL NUMBER: DCF-06-40

DEPTH TO WATER (ft): –

TOTAL DEPTH (ft): – WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ____ ft of water in casing X ____ gallons/foot = ____ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
1125	1	200	6.83	21.28	1.824	–	38.9	2.16	–
1127:30	0.25	200	6.84	20.60	1.802	–	41.8	1.50	–
1130	0.5	200	6.85	20.34	1.790	–	42.9	1.28	–
1132:30	0.75	200	6.85	20.15	1.783	–	42.7	1.16	–
1135	1.0	200	6.86	20.15	1.780	–	41.8	1.10	–

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
1135	1.0	6.86	20.15	1.780	–	41.8	1.10	–	–

FINAL DEPTH TO WATER (ft TOC): – TIME FINAL DEPTH TAKEN: –

SAMPLE ID: None SAMPLE ID FOR QC: None

PARAMETERS REQUESTED FOR ANALYSIS: None

FERROUS IRON (mg/L): 0 VOC pH: – IDW TOTAL: –

TOTAL IRON (mg/L): 0.3

DO METER MODEL No.: ~~YSI~~ ORP METER MODEL No.: YSI

DO IN AIR: – DO IN ZERO OXYGEN SOLUTION.: –

CHECKED FLOW THROUGH CELL FOR LEAKS: ☑ COMMENTS: ________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	W B McClendon	W B McClendon	08/24/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 08/23/07 SITE: DCFA PID READING at WELL HEAD (ppm): 0

OJECT NUMBER: -- WEATHER: clear, hot

WELL NUMBER

DCF 06-25

DEPTH TO WATER (ft): —

TOTAL DEPTH (ft): — WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X _____ gallons/foot = _______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ____________

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
Permangenate in Well									

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ____________

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	—	—	—	—	—	—	—	—	—

FERROUS IRON (mg/L): ____________ IDW TOTAL: ________

FINAL DEPTH TO WATER (ft TOC): ____________ TIME FINAL DEPTH TAKEN: ____________

SAMPLE ID: ____________ SAMPLE ID FOR QC: ____________

PARAMETERS REQUESTED FOR ANALYSIS: ____________

DO METER MODEL No.:__________ ORP METER MODEL No.:__________ FLOW CELL TYPE.:__________

D CHECK IN AIR: Before: ____________ After: ____________

CKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ____________

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	WB McClendon	WB McClendon	08/24/07

FIELD GROUND-WATER SAMPLING REPORT

DATE: 8/23/07 SITE: DcFA PID READING at WELL HEAD (ppm): 0

PROJECT NUMBER: WEATHER: clear, hot

WELL NUMBER: DCF 02-42 DEPTH TO WATER (ft): —

TOTAL DEPTH (ft): — WELL DIAMETER (inches): 2

PURGING

CASING VOLUME CALCULATION: ______ ft of water in casing X ______ gallons/foot = ______ total gallons/casing volume

Equipment Used: Dedicated Bladder Pump Nondedicated Bladder Pump Bailer Other ______

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)
Permanganate in well				—	—	—	—	—	—

Continued on back (circle one) yes / no

SAMPLING Equipment Used: Same as above Other ______

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D.O. (mg/L)	Depth to Water (ft TOC)	Obs.
—	—	—	—	—	—	—	—	—	—

FERROUS IRON (mg/L): — IDW TOTAL: —

FINAL DEPTH TO WATER (ft TOC): — TIME FINAL DEPTH TAKEN: —

SAMPLE ID: ______ SAMPLE ID FOR QC: ______

PARAMETERS REQUESTED FOR ANALYSIS: ______

DO METER MODEL No.: ______ ORP METER MODEL No.: ______ FLOW CELL TYPE.: ______

DO CHECK IN AIR: Before: ______ After: ______

CHECKED FLOW THROUGH CELL FOR LEAKS: ☐ COMMENTS: ______

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:	W B Mcclendon	W B McClendon	08/24/07

Appendix H
Carus Chemical Company
Technology and Quality Remediation Report

CARUS®

CARUS CHEMICAL COMPANY
Technology and Quality
Remediation Report

19 January 2006

Customer: Burns & McDonnell Engineering
9400 Ward Parkway
Kansas City, Missouri 64114

Cc: M. Dingens
K. Frasco
P. Vella
B. Veronda

Attention: John Hesemann

From: Beth Vlastnik

Keywords: $NaMnO_4$
Soil
Remediation
VOC

Tech # 10037

Subject: RemOx™ L ISCO Reagent Kinetic Demand and Soil Treatability Study

Summary

Following treatment with RemOx™ L ISCO Reagent ($NaMnO_4$), significant removals to below the detection limit were seen in cis-1,2–dichloroethene, trichloroethene, and tetrachloroethene for the aqueous phase of the samples. Vinyl chloride and trans-1,2-dichloroethene were not detected in any of the samples. No cis-1,2–dichloroethene, trichloroethene, or tetrachloroethene were detected in the soils prior to being combined with the water. After combination with the water for 10 days, some of the soil phases showed tetrachloroethene or dichloromethane. The levels found in the soil phase after treatment or in the control were low and were not correlated with the amount of permanganate added.

There was an increase seen in acetone, 2-butanone, and carbon disulfide following treatment with $NaMnO_4$ for both the aqueous and soil. In general, the concentrations of the by-products increased as the initial permanganate concentration increased. For these samples, the contaminants of concern (cis-1,2–dichloroethene, trichloroethene, and tetrachloroethene) were mostly in the groundwater. It is anticipated that they can be effectively oxidized at low treatment levels of permanganate thus avoiding any potential for the formation of oxidation by-products.

The average soil/groundwater permanganate soil oxidant demand (PSOD) for the low dose at 48 hours was estimated to be greater than 2.1 g/kg as $NaMnO_4$. The PSOD for the medium permanganate dose at 48 hours was determined to be 6.6 g/kg $NaMnO_4$. The PSOD for the high permanganate dose at 48 hours days was determined to be 10.6 g/kg $NaMnO_4$.

When converted to RemOx™ S ISCO Reagent ($KMnO_4$) the average PSOD for the low permanganate dose at 48 hours was estimated to be greater than 2.3 g/kg as $KMnO_4$. The average PSOD for the medium permanganate dose at 48 hours was determined to be 7.3 g/kg. The average PSOD for the high permanganate dose at 48 hours was determined to be 11.8 g/kg. Based on the soil demands, in-situ chemical oxidation with permanganate is recommended for this site.

Background

Four soil samples and one groundwater sample were received from Burns & McDonnell Incorporated on November 18, 2005. The soils were identified as DCFA TS-2 4 to 8 feet, DCFA TS-2 12 to 16 feet, DCFA TS-2 20 to 24 feet, and DCFA TS-2 26 to 28 feet. The groundwater was identified as DCFA DLF9b-25. It was requested that a 10-day kinetic demand study and a treatment study for volatile organic compound destruction be conducted concurrently. The groundwater and soil samples were analyzed for volatile organic compounds at the beginning of the study (prior to combining). The treated soil and groundwater samples and controls were analyzed for volatile organic compounds at the end of the reaction period.

Experimental

The moisture content for each soil sample was determined using ASTM Method D 2216-98. Concentrated permanganate dosing solutions were prepared from RemOx™ L ISCO Reagent for each soil/dose combination.

To determine the kinetic PSOD of the soils, a reaction vessel for each sample was filled with 50 grams of the soil. Next, 100 mLs of the site groundwater and 10 mLs of concentrated permanganate dosing solution were added for a 1:2.2 soil to added water ratio. The average initial permanganate concentrations were 3.0 g/kg $NaMnO_4$ (low dose), 15.2 g/kg $NaMnO_4$ (medium dose), and 30.3 g/kg $NaMnO_4$ (high dose) on a dry soil basis. These doses are equivalent to 3.4 g/kg $KMnO_4$ (low dose), 16.9 g/kg $KMnO_4$ (medium dose), and 33.7 g/kg $KMnO_4$ (high dose) on a dry soil basis. The reaction vessels were mixed twice per day by gently inverting three times per mixing session over the course of the 10-day (240-hour) reaction time. In the reactors for 4-8', 12-16' and 20-24' soils, the soil phase did not appear to mix well during this gentle mixing. Most of the soil adhered to the glass reactor. Permanganate residuals were determined at 1, 3, 6, 24, 48, 72, 96, 168, 192, 216, and 240 hours.

To show the effects of treatment with permanganate on the volatile organic compounds in the water, a reaction vessel for each sample was filled with 250 grams of the soil. Next, 500 mLs of the site groundwater and 50 mLs of concentrated permanganate dosing solution or deionized water were added for a 1:2.2 soil to added water ratio. The average initial permanganate concentrations were 0.0 g/kg $NaMnO_4$ (control), 3.0 g/kg $NaMnO_4$ (low dose), 15.2 g/kg $NaMnO_4$ (medium dose), and 30.3 g/kg $NaMnO_4$ (high dose) on a dry soil basis. These doses are equivalent to 0.0 g/kg $KMnO_4$ (control), 3.4 g/kg $KMnO_4$ (low dose), 16.9 g/kg $KMnO_4$ (medium dose), and 33.7 g/kg $KMnO_4$ (high dose) on a dry soil basis. The reaction vessels were mixed twice per day by inverting three times per mixing session over the course of the 10-day (240-hour) reaction time. In the reactors for 4-8', 12-16' and 20-24' soils, the soil phase did not appear to mix well during this gentle mixing. Residual permanganate was determined at 240 hours. At the end of the reaction time, the control and treated samples were quenched with sodium thiosulfate and sent to an outside contract laboratory for volatile organic compounds (VOC) analysis of both the soil and the aqueous portions of the reaction. An untreated portion of the soil ("pretreatment") and groundwater were submitted for VOC analysis at the start of the kinetic and VOC removal studies.

Results

The permanganate demand is the amount of permanganate consumed in a given amount of time. It should be noted that in a soil or groundwater sample, the oxidation of any compound by permanganate is dependent on the initial dose of permanganate and the reaction time available. As the permanganate dose is increased, the reaction rate and oxidant consumption may also increase. Some compounds that are not typically oxidized by permanganate under low doses can become reactive with permanganate at higher concentrations. Therefore, increasing the permanganate dose to extreme excess could be disadvantageous to a remediation project (e.g., inefficient chemical usage, higher costs, etc.).

Descriptions of the soils are presented in Table 1. Soil sample TS-2 4' - 8' contained plant matter. The presence of plant matter in a soil increases the organic content. In general, soils with higher organic content can have higher oxidant demands.

The 48-hour and 240-hour PSOD results of the soil/site groundwater for the low, medium, and high oxidant doses can be seen in Tables 2-3 (dry soil basis). These two reaction times are of particular note because 48 hours is the standard reaction period for PSOD analyses and 240 hours was the time used for the VOC removal study. The results of the kinetic study are shown in Figures 1-4 and Tables 1A-4A in the appendix.

An untreated portion of the soils ("pretreatment") and groundwater were submitted for VOC analysis at the start of the kinetic and VOC removal studies. The summary of the results of these analyses is presented in Table 4.

The soil and aqueous portions of the samples treated with water and $NaMnO_4$ were analyzed for volatile organic compounds. For comparison purposes, the VOC values for the control samples and the $NaMnO_4$ treated samples are displayed in Tables 4-7. The complete VOC data can be found in the report from STL Laboratories.

Table 1: Soil Descriptions

Sample ID	Initial Soil Moisture (%)	Soil Appearance and Type
TS-2 4' - 8'	18.8	Dark brown clay, appears to have high levels of natural organic matter, roots, some clay-like bright green areas
TS-2 12'-16'	14.4	Light brown silt
TS-2 20'-24'	11.0	Tan silt
TS-2 26'-28'	15.3	Tan sand with some clay

Table 2: The 48-hour Soil /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses (as $NaMnO_4$)

Sample ID Soil/Site Groundwater	Time (Hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)	Moisture (%)
TS-2 4' - 8'/DLF9b-25	48	>3.0 as $NaMnO_4$ >3.3 as $KMnO_4$	13.4 as $NaMnO_4$ 14.9 as $KMnO_4$	23.9 as $NaMnO_4$ 26.7 as $KMnO_4$	18.8
TS-2 12'-16'/DLF9b-25	48	2.6 as $NaMnO_4$ 2.9 as $KMnO_4$	5.6 as $NaMnO_4$ 6.2 as $KMnO_4$	7.8 as $NaMnO_4$ 8.7 as $KMnO_4$	14.4
TS-2 20'-24'/DLF9b-25	48	2.0 as $NaMnO_4$ 2.2 as $KMnO_4$	4.5 as $NaMnO_4$ 5.0 as $KMnO_4$	6.2 as $NaMnO_4$ 6.9 as $KMnO_4$	11.0
TS-2 26'-28'/DLF9b-25	48	0.8 as $NaMnO_4$ 0.9 as $KMnO_4$	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$	15.3
Average	48	>2.1 as $NaMnO_4$ >2.3 as $KMnO_4$	6.6 as $NaMnO_4$ 7.3 as $KMnO_4$	10.6 as $NaMnO_4$ 11.8 as $KMnO_4$	14.9

* All demands were calculated on a dry weight basis. To convert the demand results from a dry basis to an as received basis, multiply the dry value by 1 minus the moisture. For example, the average 48-hour $NaMnO_4$ demand from the high dose is 10.6 g/kg (dry) x (1-0.149) = 19.4 g/kg (as received).

Table 3: The 240-hour Soil /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses

Sample ID Soil/Site Groundwater	Time (Hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)	Moisture (%)
TS-2 4' - 8'/DLF9b-25	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	>30.3 as $NaMnO_4$ >33.7 as $KMnO_4$	18.8
TS-2 4' - 8'/ DLF9b-25 (VOC Reactor)	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	29.5 as $NaMnO_4$ 32.9 as $KMnO_4$	18.8
TS-2 12'-16'/DLF9b-25	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	9.5 as $NaMnO_4$ 10.6 as $KMnO_4$	12.3 as $NaMnO_4$ 13.7 as $KMnO_4$	14.4
TS-2 12'-16'/DLF9b-25 (VOC Reactor)	240	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	9.3 as $NaMnO_4$ 10.4 as $KMnO_4$	12.2 as $NaMnO_4$ 13.6 as $KMnO_4$	14.4
TS-2 20'-24' / DLF9b-25	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	7.6 as $NaMnO_4$ 8.5 as $KMnO_4$	11.6 as $NaMnO_4$ 12.9 as $KMnO_4$	11.0
TS-2 20'-24'/ DLF9b-25 (VOC Reactor)	240	2.8 as $NaMnO_4$ 3.1 as $KMnO_4$	6.3 as $NaMnO_4$ 7.0 as $KMnO_4$	8.7 as $NaMnO_4$ 9.7 as $KMnO_4$	11.0
TS-2 26'-28'/ DLF9b-25	240	1.2 as $NaMnO_4$ 1.3 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$	5.9 as $NaMnO_4$ 6.6 as $KMnO_4$	15.3
TS-2 26'-28'/ DLF9b-25 (VOC Reactor)	240	1.4 as $NaMnO_4$ 1.6 as $KMnO_4$	4.2 as $NaMnO_4$ 4.7 as $KMnO_4$	5.6 as $NaMnO_4$ 6.2 as $KMnO_4$	15.3
Average	240	>2.6 as $NaMnO_4$ >2.9 as $KMnO_4$	9.0 as $NaMnO_4$ 10.0 as $KMnO_4$	>14.5 as $NaMnO_4$ 16.1 as $KMnO_4$	14.9

* All demands were calculated on a dry weight basis.

Figure 1: The Soil/Site Groundwater Demands as $NaMnO_4$ vs. Time for the 4-8' Soil/ Site Groundwater

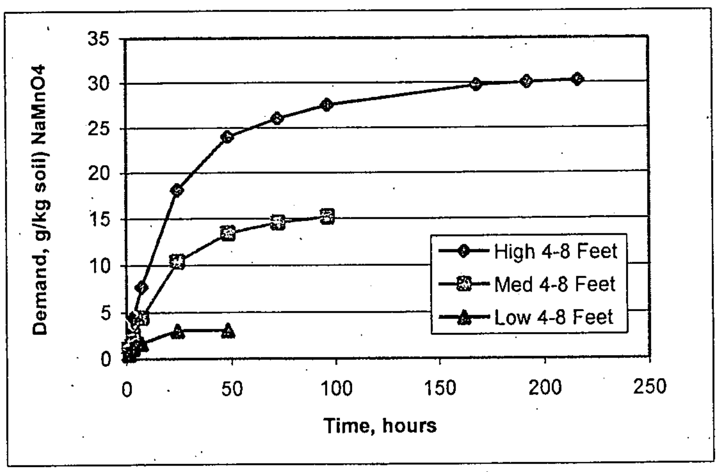


Figure 2: The Soil/Site Groundwater Demands as $NaMnO_4$ vs. Time for the 12-16' Soil/Site Groundwater

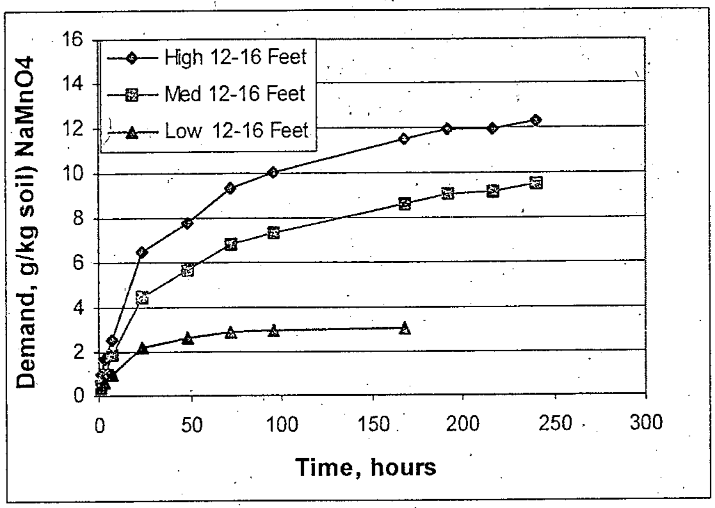


Figure 3: The Soil/Site Groundwater Demands as $NaMnO_4$ vs. Time for the 20-24' Soil/Site Groundwater

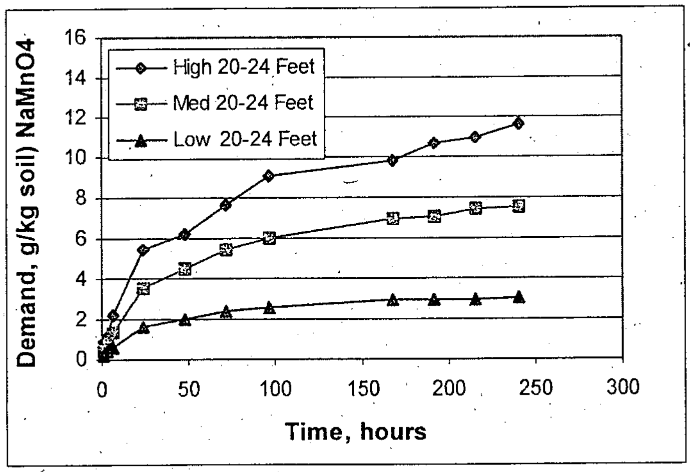


Figure 4: The Soil/Site Groundwater Demands vs. Time for the 26-28' Soil/Site Groundwater

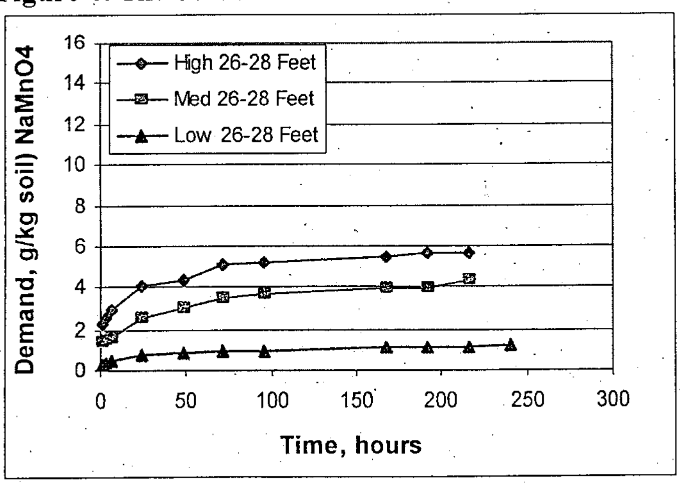


Table 4: The Pretreatment VOC Values for the Groundwater and Soil Samples

Parameter	Water DCFA (μg/L)	TS-2 Soil at 4'-8' (μg/kg)	TS-2 Soil 12'-16' (μg/kg)	TS-2 Soil 20'-24' (μg/kg)	TS-2 Soil 26'-28' (μg/kg)
Acetone	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	9.5	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND
Trichloroethene	7.3	ND	ND	ND	ND
Tetrachloroethene	63	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND
Dichloromethane	ND	ND	ND	ND	ND
Soil Moisture	NA	18.3	14.7	12.7	16.6

*Not Detected. The detection limits were 1 μg/kg for the water and ranged from 5.9 to 6.1 μg/kg for the soils.
**Not Applicable

Table 5: The VOC Values for the Groundwater and 4-8' Soil/Site Groundwater Control and Treated Samples

Parameter	Aqueous Phase Control (µg/L)	Aqueous Phase Low Dose (µg/L)	Aqueous Phase Medium Dose (µg/L)	Aqueous Phase High Dose (µg/L)	Soil Phase Control (µg/kg)	Soil Phase Low Dose (µg/kg)	Soil Phase Medium Dose (µg/kg)	Soil Phase High Dose (µg/kg)
Acetone	ND*	ND	770	910	ND	260	470	ND
cis-1,2-Dichloroethene	3.3	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	120	120	ND	ND	100	ND
Trichloroethene	1.8	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	12	2.7	ND	ND	ND	ND	ND	15**
Carbon Disulfide	ND	ND	ND	ND	ND	16	20	ND
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Moisture in Soil Phase	NA***	NA	NA	NA	28.3%	31.0%	35.6%	38.7%

* Not Detected. **Unexpected Result. ***Not Applicable

Table 6: The VOC Values for the Groundwater and 12-16' Soil/Site Groundwater Control and Treated Samples

Parameter	Aqueous Phase Control (µg/L)	Aqueous Phase Low Dose (µg/L)	Aqueous Phase Medium Dose (µg/L)	Aqueous Phase High Dose (µg/L)	Soil Phase Control (µg/kg)	Soil Phase Low Dose (µg/kg)	Soil Phase Medium Dose (µg/kg)	Soil Phase High Dose (µg/kg)
Acetone	ND*	120	400	550	ND	230	270	ND
cis-1,2-Dichloroethene	6.2	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	11	43	41	ND	24	45	ND
Trichloroethene	4.6	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	33	ND	ND	ND	ND	ND	ND	13**
Carbon Disulfide	ND	ND	ND	ND	ND	ND	93	ND
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Moisture in Soil Phase	NA***	NA	NA	NA	25.4%	23.2%	24.6%	31.1%

* Not Detected. **Unexpected Result. ***Not Applicable

Table 7: The VOC Values for the Groundwater and 20-24' Soil/Site Groundwater Control and Treated Samples

Parameter	Aqueous Phase Control (µg/L)	Aqueous Phase Low Dose (µg/L)	Aqueous Phase Medium Dose (µg/L)	Aqueous Phase High Dose (µg/L)	Soil Phase Control (µg/kg)	Soil Phase Low Dose (µg/kg)	Soil Phase Medium Dose (µg/kg)	Soil Phase High Dose (µg/kg)
Acetone	ND*	140	370	560	ND	16	130	210
cis-1,2-Dichloroethene	6.3	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	11	33	27	ND	ND	10	93
Trichloroethene	4.7	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	38	ND	ND	ND	11	ND	ND	ND
Carbon Disulfide	ND	ND	ND	47	ND	ND	28	38
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Moisture in Soil Phase	NA***	NA	NA	NA	23.5%	22.8%	24.8%	25.6%

* Not Detected. **Unexpected Result. ***Not Applicable

Table 8: The VOC Values for the Groundwater and 26-28' Soil/Site Groundwater Control and Treated Samples

Parameter	Aqueous Phase Control (µg/L)	Aqueous Phase Low Dose (µg/L)	Aqueous Phase Medium Dose (µg/L)	Aqueous Phase High Dose (µg/L)	Soil Phase Control (µg/kg)	Soil Phase Low Dose (µg/kg)	Soil Phase Medium Dose (µg/kg)	Soil Phase High Dose (µg/kg)
Acetone	ND*	130	580	1100	32	36	190	600
cis-1,2-Dichloroethene	5.7	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	16	71	88	ND	24	12	31
Trichloroethene	7.9	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	33	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND	ND	11	74
Dichloromethane	ND	ND	ND	ND	ND	8.7**	13**	ND
Moisture in Soil Phase	NA***	NA	NA	NA	32.1%	20.0%	19.4%	24.5%

* Not Detected. **Unexpected Result. ***Not Applicable

Conclusions

The soil/site groundwater samples ranged from a low demand of 4.3 g/kg as $NaMnO_4$ or 4.8 g/kg as $KMnO_4$ for the 26-28 feet depth to a moderate demand of 23.9 g/kg as $NaMnO_4$ or 26.7 g/kg as $KMnO_4$ for the 4-8 feet depth. The soil samples had a low average 48-hour permanganate demand value of 10.6 g/kg $NaMnO_4$ or 11.8 g/kg $KMnO_4$ for the high permanganate dose. Generally, remediation sites with a soil demand of less than 35.0 g/kg at 48 hours for the high permanganate dose are favorable for in-situ chemical oxidation with permanganate (see Table 9 for additional information).

Table 9: Correlation of Soil/Site Groundwater Oxidant Demand Results*

PSOD (g/kg)	**Rank**	Comment
<15	Low	ISCO with MnO_4^- is recommended, PSOD contribution to MnO_4^- demand is low
15-35	Moderate	ISCO with MnO_4^- is recommended
35-50	Moderately High	ISCO with MnO_4^- is recommended but PSOD will contribute significantly to MnO_4^- demand. Pilot testing may help define these demands.
>50	High	Pilot testing is highly recommended to determine effective PSOD at the site.

*Dry Weight Basis – Values usually as $KMnO_4$.

To estimate the quantity of permanganate needed for a remediation site using the PSOD values, it is generally recommended to use the average of all soil samples for the high permanganate dose at 48 hours. However, since there was a large amount of variation in the demand of soil sample TS-2 from 4-8 feet and the remaining soil samples analyzed in this study, it is recommended to use the 48-hour demand for the high permanganate dose for each of the soil samples. The recommended demand values to use for determining the quantity of permanganate needed for each soil type within the treatment area can be seen in Table 10.

Table 10: PSOD Values for Estimating Permanganate Quantities for Each Treatment Area

Soil Sample ID	$KMnO_4$ Demand (g/kg)	$NaMnO_4$ Demand (g/kg)
TS-2 4' - 8'	26.7	23.9
TS-2 12'-16'	8.7	7.8
TS-2 20'-24'	6.9	6.2
TS-2 26'-28'	4.8	4.3

From the data it is evident that many of the compounds found in the groundwater can be significantly decreased with $NaMnO_4$. VOC removal is a function of both reaction time and initial $NaMnO_4$ concentration. Following $NaMnO_4$ treatment, cis-1,2–dichloroethene and trichloroethene levels were decreased to below the detection limit. Tetrachloroethene levels were decreased by 77% or greater (to below the detection limit) for both the soil and aqueous phase of the samples.

The VOC levels in the soils were below the detection limit of about 6 μg/kg and the soil moistures ranged from about 11% to 19% just before combination with the groundwater. At the end of the soil/groundwater treatments, the moistures in the soil phases ranged from about 19% to 39%. These soil samples had soil phase moistures 3% to 20% greater than the initial soil moistures. For three samples (the 20-24' control, the 4-8' high $NaMnO_4$ treatment, and the 12-16' high $NaMnO_4$ treatment) tetrachloroethene was detected at values ranging from 11 to 15 μg/kg. These samples had soil phase moistures 11% to 20% greater than the initial moistures.

Since the initial level of tetrachloroethene in the groundwater was 63 µg/L, and the soil moisture of the 20-24' control increased by 11% compared to before treatment the appearance of 11 µg/kg tetrachloroethene (5 µg/kg over the detection limit) in the 20-24' control is consistent with the amount that could be from the groundwater.

The tetrachloroethene values found in the soil phases for the samples labeled 4-8' high $NaMnO_4$ dose and 12-16' high $NaMnO_4$ dose were completely unexpected. The tetrachloroethene was completely removed in the groundwater portion for all of the medium and high $NaMnO_4$ treatments. Tetrachloroethene cannot exist in the presence of permanganate for an extended period of time provided permanganate is in excess of the stoichiometric requirements for the reaction. Tetrachloroethene was not detected in the soil phase for any of the medium $NaMnO_4$ treatments. The values in the 4-8' high $NaMnO_4$ dose and the 12-16' high $NaMnO_4$ dose are believed to be an artifact of the data or lack of mixing under the constraints of the experimental setup (i.e., the groundwater was added to the soil before the permanganate dose and the soil adhered to the side of the reactor and did not move during the 3 inversions twice each day). Visually, there was a lack of permanganate observed in portions of the soil phase throughout the study, although there was permanganate present in the water phase. Further, no transitory oxidation products (acetone, 2-butanone, or carbon disulfide) were detected in these soil phases although they were present in the water phases. The absence of these transitory oxidation products indicates that there was no oxidant available to portions of the soil phase during the reaction period.

There was an increase seen in acetone, 2-butanone, and carbon disulfide following treatment with $NaMnO_4$ and quenching with sodium thiosulfate for both the aqueous and soil phase. It has been observed in the laboratory and in the field that there is a potential for the appearance of acetone following chemical oxidation. The acetone generated does not persist for very long and is not considered to be a significant factor. The exact cause for the appearance of these compounds has yet to be determined. Carbon disulfide is oxidized by permanganate in aqueous conditions. It is not known whether the appearance of carbon disulfide was caused by natural processes in the soil or was an artifact of the quenching with thiosulfate.

The VOC levels in the pretreatment groundwater sample (Table 3) were notably higher than the control samples (Tables 4 to 7) that were treated with water. The overall loss in VOCs can be attributed to volatilization during the treatment process since the reaction vessels used were not zero-headspace.

A pilot study or additional site characterization is recommended to confirm laboratory results and determine the parameters for a full-scale trial.

Appendix

Table 1A: Soil Depth 4-8 Feet /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses

Sample ID Soil/Site Groundwater	Time (hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)
TS-2 4'-8'/ DLF9b-25	1	0.46 as $NaMnO_4$ 0.51 as $KMnO_4$	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$	1.6 as $NaMnO_4$ 1.8 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	3	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$	2.5 as $NaMnO_4$ 2.8 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	7	1.6 as $NaMnO_4$ 1.8 as $KMnO_4$	4.4 as $NaMnO_4$ 4.9 as $KMnO_4$	7.6 as $NaMnO_4$ 8.5 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	24	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	10.4 as $NaMnO_4$ 11.6 as $KMnO_4$	18.0 as $NaMnO_4$ 20.0 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	48	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	13.4 as $NaMnO_4$ 14.9 as $KMnO_4$	23.9 as $NaMnO_4$ 26.7 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	72	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	14.5 as $NaMnO_4$ 16.1 as $KMnO_4$	26.0 as $NaMnO_4$ 29.0 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	96	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	15.1 as $NaMnO_4$ 16.8 as $KMnO_4$	27.5 as $NaMnO_4$ 30.6 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	168	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	29.7 as $NaMnO_4$ 33.0 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	192	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	30.0 as $NaMnO_4$ 33.4 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	216	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	30.2 as $NaMnO_4$ 33.6 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	>30.3 as $NaMnO_4$ >33.7 as $KMnO_4$
TS-2 4'-8'/ DLF9b-25 (VOC vessel)	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	>15.2 as $NaMnO_4$ >16.8 as $KMnO_4$	29.5 as $NaMnO_4$ 32.9 as $KMnO_4$

* All demands were calculated on a dry weight basis. TS-2 4'-8' had 18.8% Moisture.

Figure 1A: The Soil/Site Groundwater Demands as $KMnO_4$ vs. Time for the 4-8' Soil/ Site Groundwater

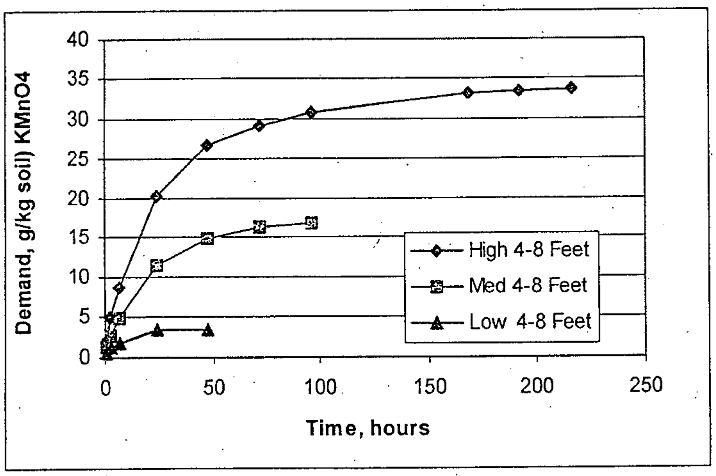


Table 2A: Soil Depth 12-16 Feet /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses

Sample ID Soil/Site Groundwater	Time (hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)
TS-2 12'-16'/ DLF9b-25	1	0.3 as $NaMnO_4$ 0.35 as $KMnO_4$	0.4 as $NaMnO_4$ 0.47 as $KMnO_4$	1.0 as $NaMnO_4$ 1.1 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	3	0.6 as $NaMnO_4$ 0.65 as $KMnO_4$	1.0 as $NaMnO_4$ 1.1 as $KMnO_4$	1.6 as $NaMnO_4$ 1.8 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	7	0.9 as $NaMnO_4$ 1.0 as $KMnO_4$	1.8 as $NaMnO_4$ 2.0 as $KMnO_4$	2.5 as $NaMnO_4$ 2.8 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	24	2.2 as $NaMnO_4$ 2.4 as $KMnO_4$	4.4 as $NaMnO_4$ 4.9 as $KMnO_4$	6.5 as $NaMnO_4$ 7.2 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	48	2.6 as $NaMnO_4$ 2.9 as $KMnO_4$	5.6 as $NaMnO_4$ 6.3 as $KMnO_4$	7.8 as $NaMnO_4$ 8.7 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	72	2.9 as $NaMnO_4$ 3.2 as $KMnO_4$	6.7 as $NaMnO_4$ 7.5 as $KMnO_4$	9.3 as $NaMnO_4$ 10.3 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	96	3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	7.3 as $NaMnO_4$ 8.2 as $KMnO_4$	10.0 as $NaMnO_4$ 11.1 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	168	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	8.6 as $NaMnO_4$ 9.6 as $KMnO_4$	11.5 as $NaMnO_4$ 12.8 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	192	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	9.0 as $NaMnO_4$ 10.0 as $KMnO_4$	11.9 as $NaMnO_4$ 13.2 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	216	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	9.1 as $NaMnO_4$ 10.2 as $KMnO_4$	12.0 as $NaMnO_4$ 13.3 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25	240	>3.0 as $NaMnO_4$ >3.4 as $KMnO_4$	9.5 as $NaMnO_4$ 10.6 as $KMnO_4$	12.3 as $NaMnO_4$ 13.7 as $KMnO_4$
TS-2 12'-16'/ DLF9b-25 (VOC vessel)	240	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	9.3 as $NaMnO_4$ 10.4 as $KMnO_4$	12.2 as $NaMnO_4$ 13.6 as $KMnO_4$

* All demands were calculated on a dry weight basis. TS-2 12'-16' had 14.4% Moisture.

Figure 2A: The Soil/Site Groundwater Demands as $KMnO_4$ vs. Time for the 12'-16' Soil/ Site Groundwater

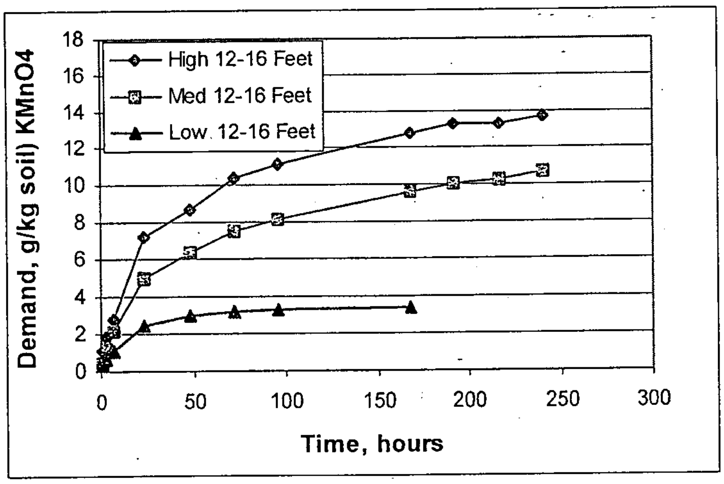


Table 3A: Soil Depth 20-24 Feet /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses

Sample ID Soil/Site Groundwater	Time (hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)
TS-2 20'-24'/ DLF9b-25	1	0.2 as $NaMnO_4$ 0.23 as $KMnO_4$	0.4 as $NaMnO_4$ 0.47 as $KMnO_4$	0.9 as $NaMnO_4$ 1.0 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	3	0.4 as $NaMnO_4$ 0.4 as $KMnO_4$	0.7 as $NaMnO_4$ 0.8 as $KMnO_4$	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	7	0.6 as $NaMnO_4$ 0.65 as $KMnO_4$	1.3 as $NaMnO_4$ 1.5 as $KMnO_4$	2.2 as $NaMnO_4$ 2.4 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	24	1.6 as $NaMnO_4$ 1.8 as $KMnO_4$	3.5 as $NaMnO_4$ 3.9 as $KMnO_4$	5.4 as $NaMnO_4$ 6.0 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	48	2.0 as $NaMnO_4$ 2.2 as $KMnO_4$	4.5 as $NaMnO_4$ 5.0 as $KMnO_4$	6.2 as $NaMnO_4$ 6.9 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	72	2.4 as $NaMnO_4$ 2.6 as $KMnO_4$	5.4 as $NaMnO_4$ 6.0 as $KMnO_4$	7.6 as $NaMnO_4$ 8.5 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	96	2.6 as $NaMnO_4$ 2.9 as $KMnO_4$	6.0 as $NaMnO_4$ 6.6 as $KMnO_4$	9.1 as $NaMnO_4$ 10.1 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	168	2.9 as $NaMnO_4$ 3.2 as $KMnO_4$	6.9 as $NaMnO_4$ 7.7 as $KMnO_4$	9.8 as $NaMnO_4$ 10.9 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	192	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	7.1 as $NaMnO_4$ 7.9 as $KMnO_4$	10.6 as $NaMnO_4$ 11.8 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	216	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	7.4 as $NaMnO_4$ 8.3 as $KMnO_4$	10.9 as $NaMnO_4$ 12.1 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25	240	>3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	7.6 as $NaMnO_4$ 8.4 as $KMnO_4$	11.6 as $NaMnO_4$ 13.0 as $KMnO_4$
TS-2 20'-24'/ DLF9b-25 (VOC vessel)	240	2.8 as $NaMnO_4$ 3.1 as $KMnO_4$	6.3 as $NaMnO_4$ 7.0 as $KMnO_4$	8.7 as $NaMnO_4$ 9.7 as $KMnO_4$

* All demands were calculated on a dry weight basis. TS-2 20'-24' had 11.0% Moisture.

Figure 3A: The Soil/Site Groundwater Demands as $KMnO_4$ vs. Time for the 20'-24' Soil/ Site Groundwater

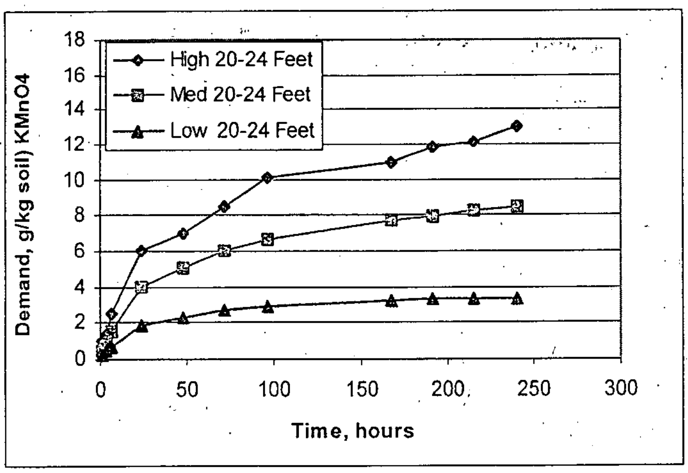
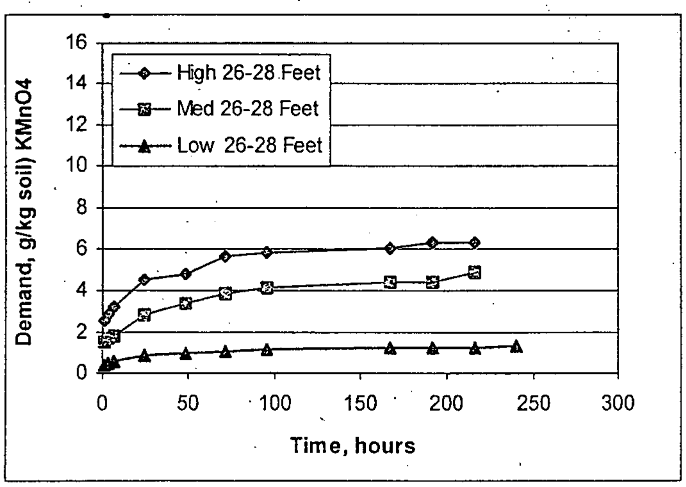


Table 4A: Soil Depth 26-28 Feet /Site Groundwater PSOD* for the Low, Medium, and High Permanganate Doses

Sample ID Soil/Site Groundwater	Time (hours)	Low Dose (g/kg)	Medium Dose (g/kg)	High Dose (g/kg)
TS-2 26'-28'/ DLF9b-25	1	0.3 as $NaMnO_4$ 0.34 as $KMnO_4$	1.4 as $NaMnO_4$ 1.6 as $KMnO_4$	2.3 as $NaMnO_4$ 2.6 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	3	0.4 as $NaMnO_4$ 0.43 as $KMnO_4$	1.5 as $NaMnO_4$ 1.7 as $KMnO_4$	2.5 as $NaMnO_4$ 2.8 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	7	0.5 as $NaMnO_4$ 0.6 as $KMnO_4$	1.6 as $NaMnO_4$ 1.8 as $KMnO_4$	2.9 as $NaMnO_4$ 3.2 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	24	0.7 as $NaMnO_4$ 0.8 as $KMnO_4$	2.5 as $NaMnO_4$ 2.8 as $KMnO_4$	4.0 as $NaMnO_4$ 4.5 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	48	0.8 as $NaMnO_4$ 0.9 as $KMnO_4$	3.0 as $NaMnO_4$ 3.3 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	72	1.0 as $NaMnO_4$ 1.1 as $KMnO_4$	3.4 as $NaMnO_4$ 3.8 as $KMnO_4$	5.0 as $NaMnO_4$ 5.6 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	96	1.0 as $NaMnO_4$ 1.1 as $KMnO_4$	3.7 as $NaMnO_4$ 4.1 as $KMnO_4$	5.2 as $NaMnO_4$ 5.8 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	168	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$	3.9 as $NaMnO_4$ 4.3 as $KMnO_4$	5.4 as $NaMnO_4$ 6.0 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	192	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$	4.0 as $NaMnO_4$ 4.4 as $KMnO_4$	5.6 as $NaMnO_4$ 6.2 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	216	1.1 as $NaMnO_4$ 1.2 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$	5.6 as $NaMnO_4$ 6.2 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25	240	1.2 as $NaMnO_4$ 1.3 as $KMnO_4$	4.3 as $NaMnO_4$ 4.8 as $KMnO_4$	5.9 as $NaMnO_4$ 6.5 as $KMnO_4$
TS-2 26'-28'/ DLF9b-25 (VOC vessel)	240	1.4 as $NaMnO_4$ 1.6 as $KMnO_4$	4.2 as $NaMnO_4$ 4.7 as $KMnO_4$	5.6 as $NaMnO_4$ 6.2 as $KMnO_4$

* All demands were calculated on a dry weight basis. TS-2 26'-28' had 15.3% Moisture.

Figure 4A: The Soil/Site Groundwater Demands as $KMnO_4$ vs. Time for the 26'-28' Soil/ Site Groundwater



3.12.3 Confirmation Soil Quality Assurance/Quality Control Procedures

QA and QC soil samples were collected during confirmation soil sampling. The USACE QA Lab analyzed the QA samples collected during selected soil sampling activities. The QC samples were analyzed by CAS. Duplicate samples were collected at a rate of 10 percent of the total samples collected for each treatment cycle. QA samples (split samples of duplicates) were submitted to the QA laboratory for analysis. A total of two duplicate and two QA samples were collected for each excavation and treatment phase. MS/MSD samples were also collected at a rate of 5 percent of total samples. One MS/MSD sample was collected at locations selected by the on-site geologist for each excavation and treatment phase.

3.12.4 Soil and Leachate Removal from the Treatment Cell

Following confirmation that COC concentrations of soil in the landfarm treatment cell were below the KDHE RSK soil to groundwater value of 180, 200, 800, and 20 μg/kg for PCE, TCE, cis-1,2-DCE, and VC respectively for each treatment cycle, the soil was removed from the treatment cell and transported to the CD for use as cover. The protective cover sand was also removed following the last treatment cycle and transported to the CD for use as cover. All treated soil removed from the treatment cell was loaded into lined and covered dump trucks for transport. This portion of the field activities was handled by Greenfield with BMcD oversight.

Leachate that collected in the sump was pumped to the holding tank and was sampled for PCE, TCE, cis1-2-DCE, and VC using USEPA Method 8260B. Following verification that the results were either ND or were equal to or less than the results reported for purge water removed from the monitoring well network during groundwater sampling events, the leachate was discharged to MH 96 at Camp Funston in accordance with the site-specific IDWMP. The IDW tank was sampled and emptied on three separate occasions. The results of the leachate confirmation sampling are presented in Section 4.

3.12.5 Dismantling of the Landfarm Treatment Cell

Once the treated soil and protective cover sand were removed, the treatment cell was dismantled. This portion of the field activities was handled by Greenfield with BMcD oversight. The HDPE liner was cut into pieces and removed. The liner was disposed of by Greenfield. Following removal of the liner, the excavation subcontractor graded the earthen berm, filled in the sump, and the area was reseeded with a standard NRCS native grass mix.

3.13 AOC 3 VADOSE ZONE CHEMICAL OXIDATION APPLICATION AND METHODOLOGY

A chemical oxidation treatment consisting of an aqueous $NaMnO_4$ solution was injected into the vadose zone around Monitoring Well DCF02-42 to address a subsurface chlorinated solvent soil source area identified during the vadose zone assessment (Figure 3-9). The removal of this source area will reduce the infiltration of precipitation through a contaminated soil source zone to groundwater. Application of chemical oxidation by injection into the subsurface required a KDHE Bureau of Water Class V Injection Permit (Appendix A). Based on the type of injection (remedial), KDHE granted an exception for a Class V injection and allowed a one time treatment at the DCF site.

3.13.1 Chemical Oxidation Dosage

The oxidant consisted of a 3% (by weight) aqueous $NaMnO_4$ solution. The oxidant was injected into the subsurface vadose zone in an approximate 25-foot by 13-foot area centered around Monitoring Well DCF02-42. At several locations, the $NaMnO_4$ solution was also injected into the saturated zone to reach the target injection volume for those specific locations. The aqueous $NaMnO_4$ solution was injected in multiple intervals from 5 to 32 feet bgs (Table 3-1). The soil types in this interval included silt, clay, and sand. The mass of $NaMnO_4$ required for treatment was determined using the results of the treatability bench tests conducted on soil samples collected in this area. The total mass of $NaMnO_4$ applied to the vadose zone was approximately 7,400 pounds. The oxidant was applied through direct-push rods at 23 locations, spaced throughout the injection area. Between 182 and 590 gallons of 3% $NaMnO_4$ solution were injected at each location for a total volume of approximately 11,500 gallons. At several locations, the amount of oxidant delivered to the subsurface was reduced due to subsurface permeability issues which caused daylighting of the $NaMnO_4$. The injection load targeted for those low permeability locations that were not injected were added to the injection locations in the immediate surrounding areas.

3.13.2 Chemical Oxidation Application

The aqueous $NaMnO_4$ solution was injected into the vadose zone at each injection location through direct push rods using an injection pump, delivery hose, and mobile injection trailer. Injection activities were conducted in two separate phases due to inclement weather during late January/early February and late February 2006. The mobile injection trailer was equipped with mixing tanks, transfer pumps, valves, piping, and instrumentation necessary for chemical mixing and delivery. The 3% $NaMnO_4$ solution was created in the mixing tanks by combining 40% $NaMnO_4$, obtained from the manufacturer, with water from the designated non-chlorinated hydrant. The oxidant solution was fed by gravity to the injection pump. The injection pump was connected to direct-push rods using a high-pressure hose and the rods were equipped with an injection probe tip.

Oxidant injection at each location was accomplished using a "top-down" direct-push injection method with the exception of VI-7, which used the "bottom-up" method. For the "top-down" method, the direct-push rods were initially advanced to approximately 5 foot bgs. A predetermined volume of oxidant solution was then injected using the injection pump. After injecting the desired volume, the direct-push rods were advanced to the next interval and the injection process was repeated. The process was repeated until the direct-push rods were advanced to a maximum depth of 32 feet bgs. A totalizing flow meter was used to monitor the oxidant flow rate and cumulative volume injected. This portion of the field activities was handled by EPS with BMcD oversight.

3.13.3 Post-Injection Performance Monitoring

The performance monitoring program for the vadose zone chemical oxidation consisted of groundwater parameter monitoring at Monitoring Wells DCF02-42 and DCF06-25. Monitoring Well DCF02-42 was used because it was located in the middle of the injection area and Monitoring Well DCF06-25 was used because this was the immediate downgradient well. Due to scheduling constraints and access issues into the Eagle buffer zone, Piezometer PSPZ-1 was not installed until April 17, 2006. Pre-injection performance monitoring data was collected prior to vadose zone injection during the spring and fall 2005 groundwater sampling events. Post-injection monitoring was conducted on March 15, 2006, during the spring 2006 groundwater sampling event, on April 18, 2006 during installation of the horizontal boring jack-pit, and was then combined with the post- performance monitoring for the high-pressure and EAB injection activities conducted for AOC 3 and AOC 2 (see Table 3-2). Parameters measured during pre/post performance monitoring included visual observation for the presence of MnO_4^- and manganese dioxide, and field measurements for oxidation reduction potential (ORP) and pH. If the MnO_4^- was detected in the well, then ORP and pH data were not collected. This portion of the field activities was handled by BMcD.

3.14 SPRING 2006 GROUNDWATER SAMPLING EVENT

A groundwater sampling event was conducted in March 2006 to provide a second baseline for chlorinated solvent concentrations and natural attenuation parameters in AOC 2 and AOC 3 before high pressure and EAB injection activities were conducted. The sampling and analytical requirements for this event are presented in Table 3-3. All monitoring wells were purged and sampled based on the USACE Low Flow Protocol-Version 1.3 (USACE, 2002) with the exception of the manual inertial lift pump wells which were purged using a modified set of criteria. Analytical groundwater samples were not collected from monitoring wells where MnO_4^- was present. All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS and QA samples were sent to the USACE laboratory in Omaha, Nebraska. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, Spring 2006 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2006a). The groundwater results for this sampling event are presented in Section 4.

3.15 PIEZOMETER INSTALLATION

Prior to $KMnO_4$ injection at AOC 3, a temporary piezometer (PSPZ-1) was installed and developed using a direct-push rig on April 17, 2006 (Figure 3-10). The piezometer was a 1.4 inch outside diameter (OD) prepack groundwater piezometer (with a 0.75 inch inside diameter [ID] well). The piezometer was installed by driving probe rods to refusal at 29.81 ft bgs. Once probe refusal was reached, one quart of purge water was removed using a manual inertial lift pump and a VOC groundwater sample was collected. The sample was sent to CAS for analysis of VOCs using USEPA Method 8260B. A MS/MSD sample was also collected. The results for this baseline groundwater sample are presented in Section 4.

Following sampling, a 10 ft prepack well screen assembly with 24 ft of threaded PVC riser pipe was then lowered through the probe rods. Once the prepack piezometer assembly was installed to the bottom of the probe boring, the probe rods were retracted to one foot above the top of the prepack screen. A 2 foot thick fine grained sand barrier was installed through the rod annulus directly above the well screen to a as the probe rods were slowly retracted. Once the barrier was in place, granular bentonite hydrated in one-foot lifts was installed in the annulus to the ground surface. A small 2-ft by 2-ft concrete surface pad was constructed with a protective cover. Bumper posts were not installed. A piezometer diagram is provided in Appendix D.

Following installation, the piezometer was developed. All development parameters including the static water level and total depth were recorded on a Well Development Form (Appendix D). Additionally, initial pH, conductivity, temperature, and turbidity measurements were recorded prior to commencement of well development. All instruments were calibrated according to manufacturers' specifications prior to use and as stated in the FSP. All instrument calibrations were recorded on a Daily Calibration Log (Appendix D). Piezometer development was conducted using a small diameter bladder pump. pH, conductivity, temperature, and turbidity measurements were measured during well development as stabilization criteria. During piezometer development, periodic measurements of the stabilization criteria were recorded on the Well Development Form. All parameters stabililized after removal of 5.7 gallons of monitoring wells where MnO_4^- was present. All groundwater samples were sent to CAS in Salina, Kansas for analysis. QC samples were also sent to CAS and QA samples were sent to the USACE laboratory in Omaha, Nebraska. The monitoring well network for this sampling event is shown on Figure 1-2. Additional information for this groundwater sampling event is presented in the *Quality Control Summary Report, Spring 2006 Groundwater Sampling Event at the Dry Cleaning Facilities Area at Main Post, Fort Riley, Kansas,* (BMcD, 2006a). The groundwater results for this sampling event are presented in Section 4.

3.15 PIEZOMETER INSTALLATION

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Following sampling, a 10 ft prepack well screen assembly with 24 ft of threaded PVC riser pipe was then lowered through the probe rods. Once the prepack piezometer assembly was installed to the bottom of the probe boring, the probe rods were retracted to one foot above the top of the prepack screen. A 2 foot thick fine grained sand barrier was installed through the rod annulus directly above the well screen to a as the probe rods were slowly retracted. Once the barrier was in place, granular bentonite hydrated in one-foot lifts was installed in the annulus to the ground surface. A small 2-ft by 2-ft concrete surface pad was constructed with a protective cover. Bumper posts were not installed. A piezometer diagram is provided in Appendix D.

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3.16 AOC 3 SATURATED ZONE CHEMICAL OXIDATION APPLICATION AND METHODOLOGY

3.16.1 General

This portion of the pilot study involved in-situ treatment using a high pressure injection of $KMnO_4$. This treatment method focused on treating the saturated zone overlying the bedrock in the area located between Monitoring Well DCF02-42 and Monitoring Well DCF06-25 (Figure 3-10). This area is located in the western portion of the pilot study area (Figure 1-2). Injection in this area was conducted from April 21 through May 3, 2006. $KMnO_4$ can destroy contaminants by either direct electron transfer or free radical advanced oxidation, and is a selective oxidant in that it has the potential to be less reactive with some of the natural organics and can persist longer in the subsurface than Fenton's reagent or ozone. $KMnO_4$ is generally effective in treating chlorinated ethenes (i.e., PCE, TCE, and cis-1,2-DCE).

$KMnO_4$ was applied to the saturated zone for groundwater remediation in AOC 3 in the area from Monitoring Well DCF02-42 to approximately 63 feet southeast of Monitoring Well DCF06-25. The saturated zone has an approximate thickness of 1.0 ft around Monitoring Well DCF02-42 and increases in saturated thickness to approximately 10 ft at Monitoring Well DCF06-25. The $KMnO_4$ treatment area was approximately 180 ft long (not including the UPRR grade) by 60 ft wide. North of the UPRR grade near Monitoring Well DCF02-42, the treatment interval was approximately 29.5 ft bgs based on the depth to water and thickness of the water column in this area (1 foot). South of the UPRR grade, the treatment zone extended from the water table at approximately 20 ft bgs to the bedrock surface at approximately 32 ft bgs and varied in thickness from 1 to 10 ft. The average treatment interval thickness was five feet. The soil type in the saturated zone was predominantly sand. $KMnO_4$ was applied to 44 locations; two locations north of the UPRR near Monitoring Well DCF 02-42 and 42 locations south of the UPRR (Figure 3-10). This portion of the field activities was handled by FRX and EPS with BMcD oversight.

3.16.2 Horizontal Boring

During the pre-pilot study walk through at AOC 3 by Fort Riley, BMcD, and FRX personnel, it was determined that equipment movement and storage on the Island during high pressure injection activities would cause considerable damage to the Island ecological habitat. To avoid this, a decision was made to locate all of the injection mixing equipment and chemical storage units north of the UPRR tracks. The chemical and water lines necessary for direct-push high pressure injection on the Island were routed through three horizontal casings installed beneath the UPRR tracks. The UPRR permit for the installation of the three temporary horizontal casings was obtained by BMcD in April 2006 (Section 3.6.3.2). To install the three horizontal casings, a jack-pit was excavated by M&D Excavating of Hays, Kansas on April 17, 2006. The jack pit was approximately 8 ft deep, 12 feet wide in the north/south direction, and 22 ft in length with a sloped entrance oriented in the east/west direction. The three horizontal casings were installed on April 18, 2006. The three horizontal casings extended from the jack pit located north of Monitoring Well DCF 02-42 to the Island (Figure 3-11). Each horizontal casing was approximately 80 ft in length.

3.16.3 $KMnO_4$ Application

The high-pressure jetting technique with high radial injection coverage was the method used for $KMnO_4$ emplacement in this portion of AOC 3. The jetting process produced a disc-shaped distribution (radial) composed of a $KMnO_4$/sand/bentonite/water mixture. The high-pressure jetting technique emplaced the oxidant slurry through direct-push rods at 44 locations, spaced throughout the injection area on a 15 ft grid (Figure 3-10 and Table 3-4). At each location, there were two treatment intervals spaced approximately 5 feet apart. The treatment intervals for each adjacent location were staggered at either 22/27 ft bgs or 23/28 ft bgs. This treatment configuration allowed for overlapping treatment zones in the vertical direction. Oxidant injection at each location was accomplished using a "top-down" direct-push injection method. Approximately 500 pounds of $KMnO_4$ was emplaced at each location with approximately 250 pounds of $KMnO_4$ injected at each interval. At several locations, the amount of oxidant delivered to the subsurface was reduced due to subsurface permeability issues which caused daylighting. The injection load targeted for those low permeability locations that was not injected were added to the injection locations in the immediate surrounding area.

The high-pressure jetting method of $KMnO_4$ emplacement employed a series of jets, directed horizontally, positioned 90 degrees from each other, and evenly spaced along the vertical axis of the jetting lance. Prior to jetting, a two inch diameter casing was advanced to the base of the targeted interval using direct-push techniques. Following installation of the casing, the lance was lowered to the base of the casing and the casing was retracted to expose the jets to the formation. High-pressure jetting was then initiated by injecting a slurry, composed of water, bentonite, and $KMnO_4$, at pressures up to 10,000 pounds per square inch (psi), mixing the oxidant slurry and sand formation until approximately 250 pounds of $KMnO_4$ was emplaced at each interval. A total of 21,755 pounds of $KMnO_4$ was injected into the saturated zone in this treatment area. Approximately 100 to 350 gallons of water was used at each location to emplace the oxidant for a total of 13,120 gallons. The designated non-chlorinated hydrant was used as the water source.

through three horizontal casings installed beneath the UPRR tracks. The UPRR permit for the installation of the three temporary horizontal casings was obtained by BMcD in April 2006 (Section 3.6.3.2). To install the three horizontal casings, a jack-pit was excavated by M&D Excavating of Hays, Kansas on April 17, 2006. The jack pit was approximately 8 ft deep, 12 feet wide in the north/south direction, and 22 ft in length with a sloped entrance oriented in the east/west direction. The three horizontal casings were installed on April 18, 2006. The three horizontal casings extended from the jack pit located north of Monitoring Well DCF 02-42 to the Island (Figure 3-11). Each horizontal casing was approximately 80 ft in length.

3.16.3 $KMnO_4$ Application

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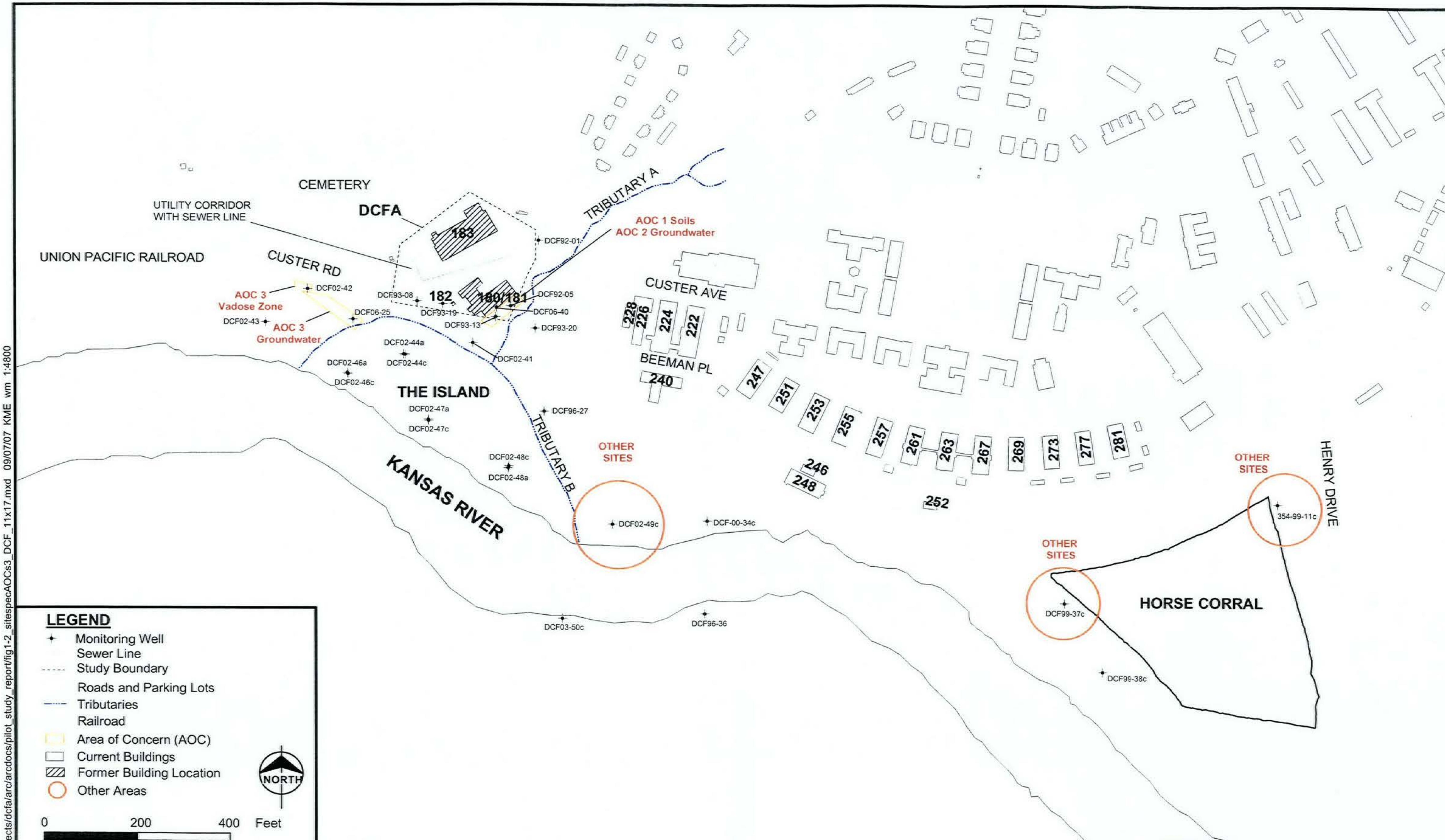

NOTES:

1. River bank based on aerial photography collected on February 8, 1998.

Burns & McDonnell

Figure 1-2
SITE SPECIFIC AREAS OF CONCERN

Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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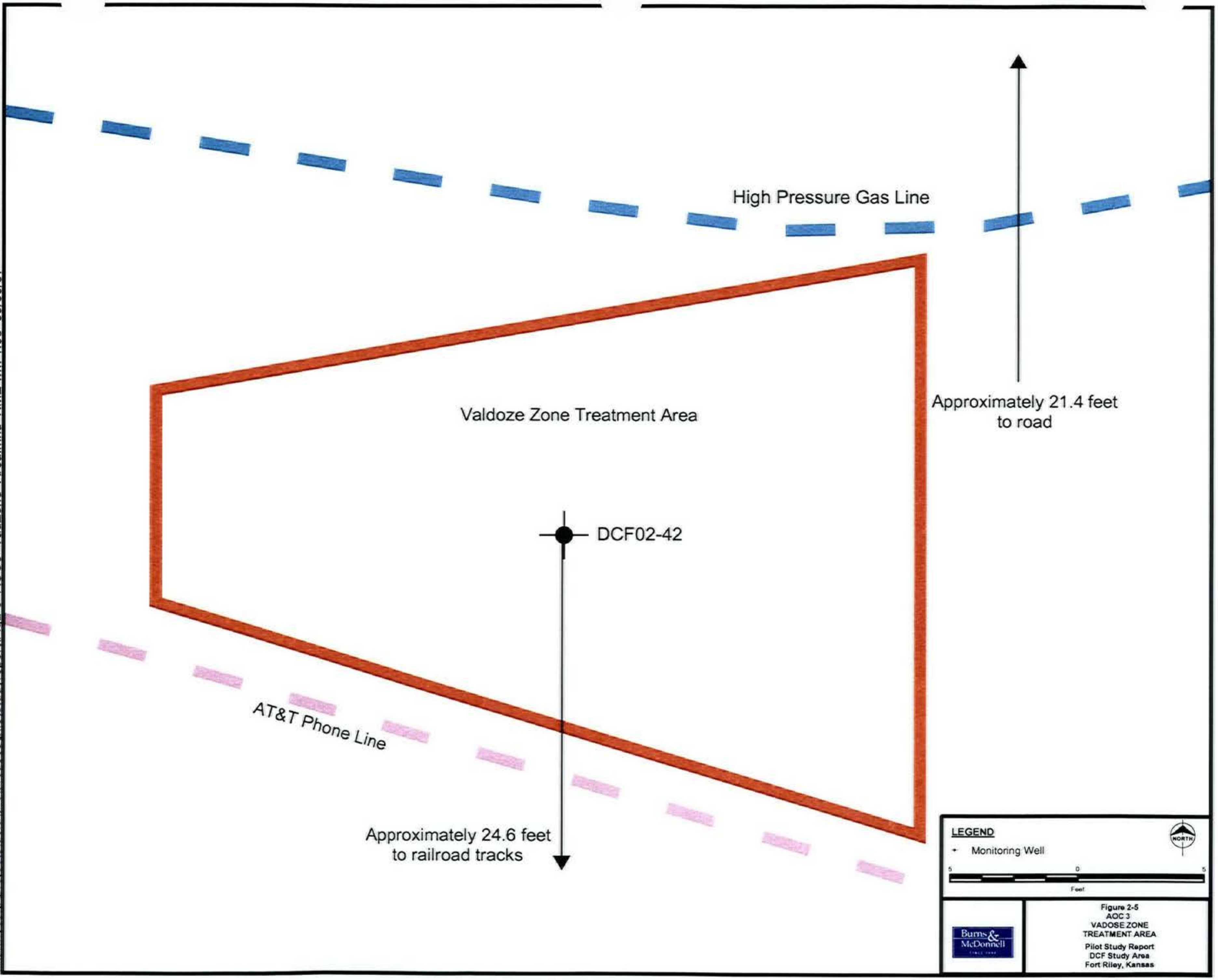

Figure 2-5
AOC 3
VADOSE ZONE
TREATMENT AREA
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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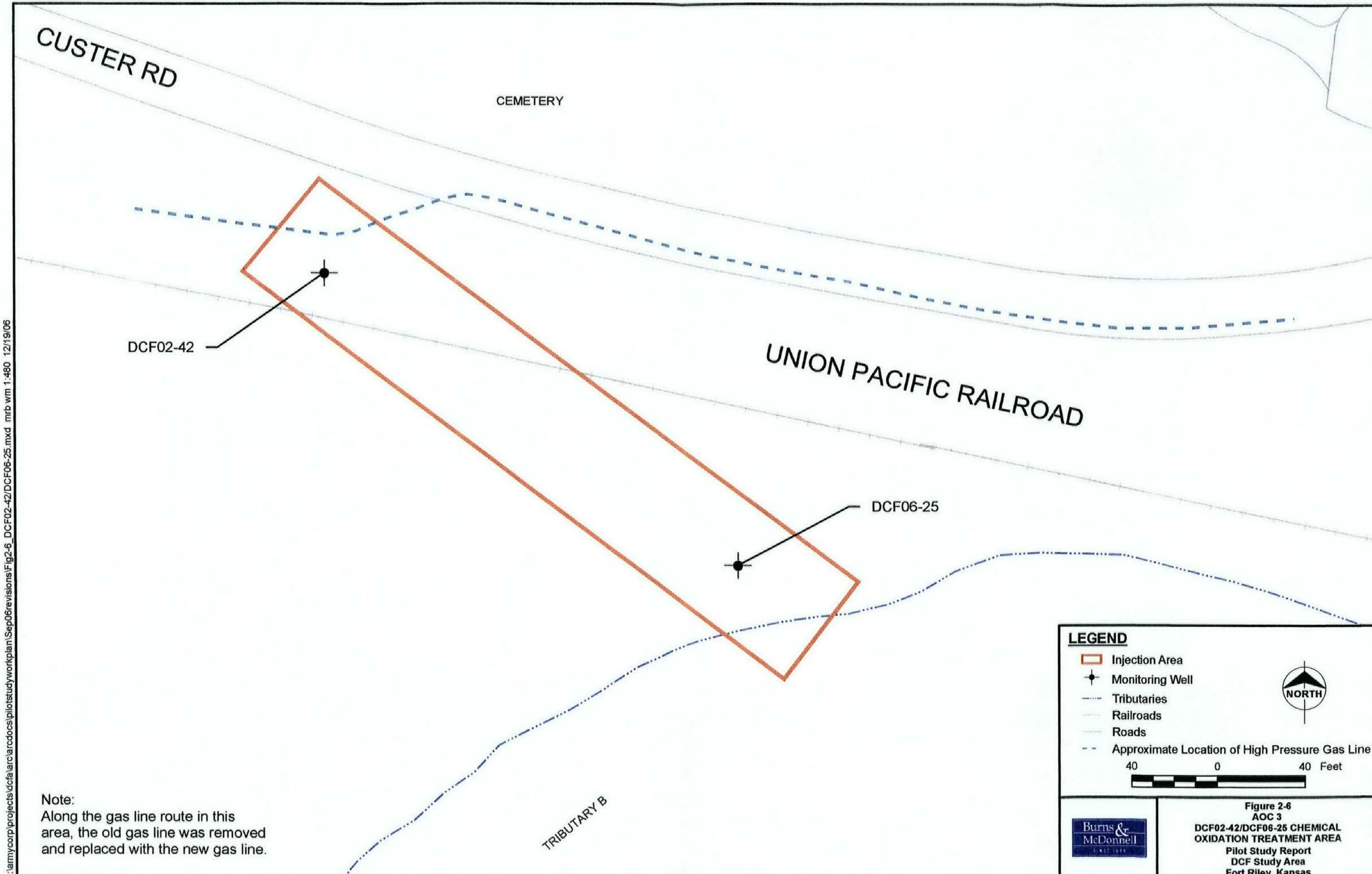

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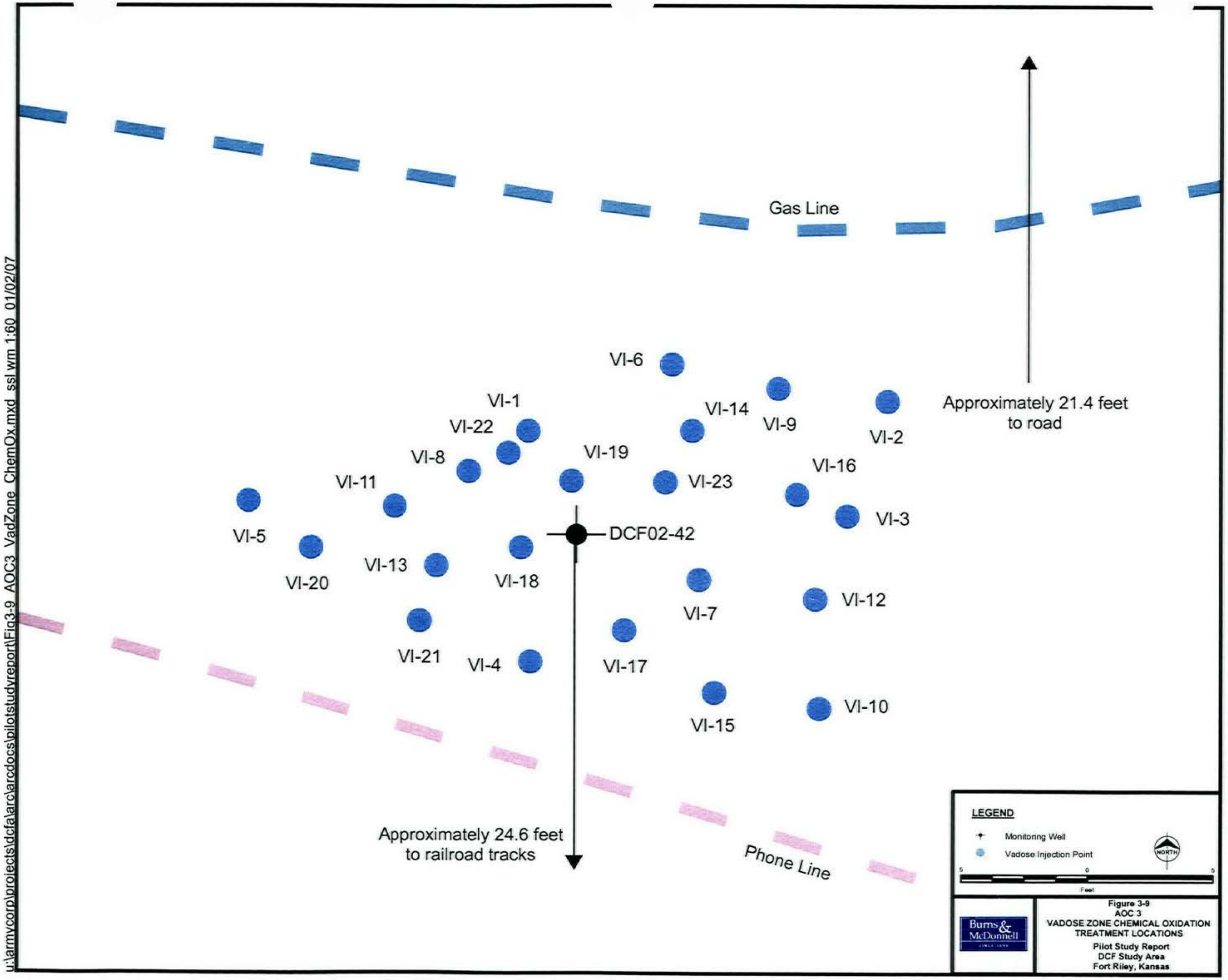

Figure 3-9
AOC 3
VADOSE ZONE CHEMICAL OXIDATION TREATMENT LOCATIONS
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

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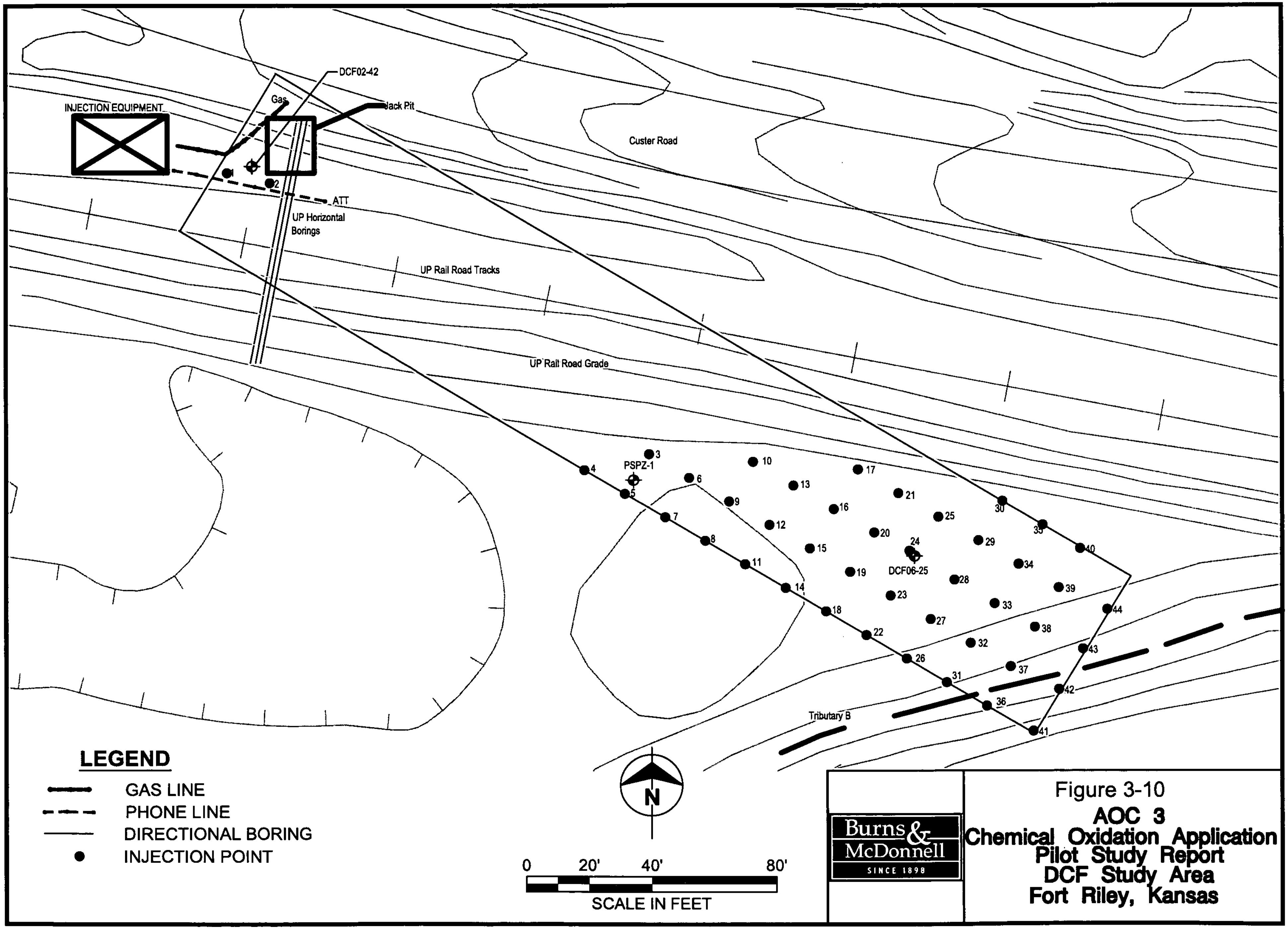

Figure 3-10
AOC 3
Chemical Oxidation Application
Pilot Study Report
DCF Study Area
Fort Riley, Kansas

K:\ENV\ENVIRONMENTAL CHEMICAL CORPORATION\SITE\40904\DELIVER\PILOT STUDY REPORT\DRAFT\FIGURES\FIGURE 3-10.DWG 12-14-2007 16:23 KEVERETT